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Assessment of the 2001 Snow crab (*Chionoecetes opilio*) fishery off eastern Nova Scotia (Areas 20 to 24)

Évaluation des pêcheries de crabe des neiges (*Chionoecetes opilio*) de l'est de la Nouvelle-Écosse (zones 20 à 24) en 2001

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Abstract

In 2001, compared to 2000, mean catch-per-unit-effort (CPUE) increased in eastern Nova Scotia (ENS) in Crab Fishing Areas (CFA) 20, 21, 22, 24 and all sub-areas in CFA 23 except 23D. As in 2000, the magnitude of certain increases in CPUEs may be considered 'inflated' by factors such as gear type, soak time, fishing season and pattern, and crab movement. Landings in ENS were 9,917 t in 2001 (excluding the exploratory trap survey on the slope of the Scotian Shelf). Trends in CPUE in all CFAs since 1995 did not suggest any stock decline. Better coverage from at-sea sampling showed high levels of commercial-sized soft and white crab categories appeared in the catches after the month of August in most areas.

Trawl survey data clearly indicated that recruitment to these fisheries and mature females have been consistently decreasing since the survey began in 1997/98. In northern ENS (CFAs 20, 21 and 22), a new relative abundance index will be established based on a trawl survey to be conducted in September instead of May, as in previous years. An experimental trawl survey in the fall of 2001 has indicated that the decreasing trend in immediate recruitment in northern ENS might have been accentuated by the timing of the survey (earlier starting dates) combined with seasonal crab movement. In southern ENS (CFAs 23 and 24), sources of underestimation have been eliminated from the biomass estimation process, while known sources of mortality were better accounted for. This has resulted in a relative abundance index that best represents the snow crab population, but it was also less conservative (i.e. with less sources of underestimation being ignored as in the past) compared to previous years. Commercial-sized male categories observed before the fishery in 2001 were similar to those of 2000. A decreasing trend in both recruitment and commercial-sized adult crab should be considered when managing the northern and southern ENS stocks in coming years.

Résumé

En 2001, lorsque comparé à 2000, les prises par unité d'effort (PUE) moyennes ont augmenté à l'est de la Nouvelle-Écosse (ENÉ) dans les zones de pêche du crabe (ZPC) 20, 21, 22, 24, ainsi que toutes les sous-zones de ZPC 23, sauf pour 23D. Comme en 2000, l'amplitude de certaines augmentations de la PUE peut être considérée «gonflée» par des facteurs tels que le type d'engin de pêche, le temps d'immersion, la saison et les habitudes de pêche, et le mouvement des crabes. Les débarquements ont été de 9,917 t en 2001 (excluant le relevé exploratoire à l'aide de casiers le long du thalus du plateau néo-écossais). La tendance dans les PUE de toutes les ZPC depuis 1995 ne suggèrait pas de déclin du stock de crabes des neiges. Une meilleure couverture dans l'échantillonnage en mer a démontré que des hauts niveaux dans les catégories de crabes commerciaux mous et blancs ont apparu dans les prises après le mois d'août dans la plupart des zones.

Les données du relevé au chalut indiquaient clairement que le recrutement de ces pêcheries et les femelles adultes ont constamment diminué depuis que le relevé a commencé en 1997/98. Dans la partie nord de ENÉ (ZPC 20, 21 et 22), un nouvel indice d'abondance relative sera établi à partir d'un relevé au chalut qui sera réalisé en septembre plutôt qu'en mai, ce qui était le cas dans le passé. Un relevé au chalut expérimental à l'automne de 2001 a démontré que la tendance à la diminution dans le recrutement immédiat de la partie nord de ENÉ peut avoir été accentuée par la date de début du relevé (de plus en plus tôt), combiné au déplacement saisonnier de crabes. Dans la partie sud de ENÉ (ZPC 23 et 24), des sources de sous-estimation ont été éliminées de la procédure d'estimation de la biomasse, alors que les sources de mortalité connues ont été mieux estimées. Ceci a eu pour conséquence de produire un indice d'abondance relative qui représente mieux la population de crabe des neiges, mais elle est aussi moins conservative (c.à.d. avec moins de sources de sous-estimation qui était ignorée comme auparavant). Les catégories de mâles de taille commerciale qui ont été observées avant la pêcherie en 2001 étaient similaires à celles de 2000. Une tendance à la diminution du recrutement et des crabes adultes de taille commerciale devrait être considérée lors de la gestion du stock des parties nord et sud de ENÉ durant les prochaines années.

INTRODUCTION

History – Harvesting of snow crab off the coast of eastern Nova Scotia (ENS) began in the late 1970's. Landings rose to a peak of 1,634 t in 1979. Landings and catch-per-unit-effort (CPUE) then collapsed within four fishing seasons and by 1985 this fishery was believed to be near commercial extinction. However, a pulse of pre-recruits entered the commercial catches of snow crab in all Crab Fishing Areas (CFAs) in 1986 and landings rose from 1989 to 1993 when peak levels were reached at 2,016 t (Tremblay, Eagles and Elner, 1994). In 1994, total landings declined by 23% to 1,551 t and remained stable at that level in 1995 and 1996. The landings increased to 1,677 t in 1997, 2,238 t in 1998 and 3,599 t in 1999.

From 1982 to 1993, the management of these fisheries was based strictly on effort controls (seasons, licenses and trap limits). Substantial changes to management measures were introduced in each CFA from 1994 to 1999; Individual Boat Quotas (IBQ) were imposed in all CFAs; 100% dockside monitoring; a mandatory logbook for both dockside monitoring and the scientific data base; landings not more than 10% soft-shell crabs; at-sea monitoring by certified observers; a biodegradable panel on traps to prevent ghost fishing; the introduction of sub-areas in 1998 to ensure the distribution of the fishing effort; and the number of traps allowed was increased from 30 to 40 in CFA 24 in 1999. In CFA 22, an industry-designed separation of the fleet (since 1996) into northern and outer areas was incorporated into the management plan (with a separate Total Allowable Catch (TAC) designed for each area) and fishermen were supposed to fish in only one area. The number of permanent licenses in northern ENS remained unchanged from 1994 to 1999 at 5 licenses in CFA 20, 32 in CFA 21 and 37 in CFA 22. During this same period, no temporary allocations were allowed in CFAs 21 and 22, while 4 temporary permits were issued in CFA 20 in 1999. The number of permanent licenses increased from 22 to 24 in CFA 23 and from 21 to 23 CFA 24 in 1997, which remained the same in 1998-99. The number of temporary permits has increased from 5 in 1996 to 13 in 1999 in CFA 23 and from 6 to 22 permits in CFA 24.

In 1999, for the first time in ENS, the stock status was evaluated based on a trawl survey, which began in 1997. At that time (1999), estimates of the minimum trawlable biomass (referred to as total biomass hereafter) for the 2000 season were 2,358 ± 2,285 t for the northern region (CFAs 20 to 22) and 28,939 ± 13,499 t for the southern region (CFAs 23 and 24). The size frequency distributions showed a substantial decrease in future recruitment from 1997 to 1999 in both the northern and southern regions, while the commercially exploitable crab remained stable. Trends in CPUE in all CFAs during the same period did not suggest any sign of stock decline. Increases in TAC for all CFAs were decided during the Management / Industry Consultative Process that preceded the snow crab fishing season in 2000. In northern ENS, the TAC increased to 1,015 t (from 899.4 t in 1999). In southern ENS, it increased to 8,799 t (from 2,700 t in 1999). In 2000, the TAC increased from 90.6 t to 118 t in CFA 20; from 290 t to 363 t in CFA 21; from 302.6 t to 318 t in 'CFA 22 northern' (while remaining the same at 216 t in 'CFA 22 outer'); from 1,300 t to 4,425 t in CFA 23; and from 1,400 t to 4,374 t in CFA 24. Existing allocations for temporary fishermen increased from 33.9 t to 50 t in CFA 20, from 400 t to 2,683 t in CFA 23, and from 575 t to 2,686 t in CFA 24. There were no changes in the number of permanent licenses in all CFAs, but the number of temporary permit holders increased from 4 in 1999 to 5 in 2000 in CFA 20, from 13 to 53 in CFA 23, and from 22 to 56 in CFA 24. Some modifications

were made on the boundaries of the outside sub-areas in southern ENS and the number of traps allowed was increased from 30 to 45 in CFA 23.

Current status – In northern ENS, there was no change in the TAC in CFA 20 (118 t), CFA 21 (363 t) and CFA 22 northern (318 t) compared to 2000, but there was a 50 t increase in CFA 22 outer (from 216 t to 267 t)(Table 1). However, since 3 fishermen changed their fishing ground from CFA 22 northern to CFA 22 outer in 2001, most of the increase in the resulting IBQ was actually felt in CFA 22 northern. In 2001, IBQs increased from 13,834 to 15,900 kg in CFA 22 northern and from 15,422 to 15,706 kg in CFA 22 'outer' (Table 1).

There was an increase in TAC from 4,425 t in 2000 to 4,761 t in 2001 in CFA 23, but a decrease from 4,374 t to 4,062 t in CFA 24, for an overall increase in TAC from 8,799 t to 8,823 t in southern ENS. In 2001, IBQs of regular license holders increased in CFA 23 (from 72,601 to 74,004 kg) and decreased in CFA 24 (from 73,402 to 72,009 kg) (Table 1). Existing allocations for temporary fishermen increased from 2,683 t to 2,985 t in CFA 23, and decreased from 2,686 t to 2,406 t in CFA 24 (Table 1). In each of CFAs 23 and 24, 100 t of 'new allocation' was given to 3 exploratory permits to realise a trap survey along the slope of the Scotian Shelf. There were no changes in the number of permanent licenses (5 licenses in CFA 20, 32 in CFA 21, 37 in CFA 22, 24 in CFA 23, and 23 in CFA 24). The number of temporary permit holders increased from 5 to 6 in CFA 20, from 53 to 61 in CFA 23, and from 56 to 59 in CFA 24, compared to 2000. Other management items remained similar to those in 2000 for all the CFAs.

MATERIALS AND METHODS

Landings, catch rate and effort

Commercial catch rates – Catch-per-unit-effort (CPUE) data have been used to provide an index of stock abundance in ENS until the introduction of trawl survey results in 1999. These data were obtained from the mandatory logbooks (also used for dockside monitoring) that collect information on catch, effort in number of trap hauls, soak time, trap type, depth, position (latitude/longitude), and date fished and/or landed. Copies of the original completed logs and the compiled electronic database were obtained from the Statistics Division of the Maritimes Region of the Department of Fisheries and Oceans (DFO). Thereafter, total seasonal landings for each CFA were obtained from a revised preliminary report produced by the Statistics Division in late December 2001. The average CPUE was estimated as the ratio of the sum of the landings (y) to the sum of the corresponding number of traps hauled (th) based on properly completed logs only (93%): CPUE = $\sum y / \sum th$. Total effort (number of traps hauled) was estimated by dividing total landings by average CPUE. Information on fishing location is used to map the distribution of landings, CPUE, and fishing effort.

Management areas and sub-areas – Since 1998, DFO Management, in consultation with the Industry and DFO Science (Biron et al. 1998), has set (and/or modified) sub-areas in most CFAs of ENS to ensure the proper distribution of the fishing effort over fishable grounds. There was no change in the boundaries of CFAs and sub-areas for northern and southern ENS as described in 2000 (Fig. 1)(Biron et al. 2001). Landings, CPUE, and fishing effort were presented on the basis of these management areas and sub-areas.

Catch-effort maximum likelihood biomass estimations in CFAs 21 and 22 – In contrast to southern ENS, the fisheries in northern ENS have been basically concentrated in two well defined fishing grounds: (1) the nearshore trough, which is shared by all fishermen of CFAs 21 and 22 northern, as well some of the fishermen in CFA 20; and (2) an area along the Laurentian Channel, also known as the Glace Bay Hole, that comprises the majority of the fishing activities of CFA 22 outer fishermen (Biron et al. 2001). Because of the very limited fishing surface, combined with a short fishing period (10 days), and a high intensity of fishing effort, it is considered that catch-effort-based method's assumptions are met (at acceptable level) without many violations. The catch-effort method was applied to the 2 fishing grounds in northern ENS as an alternate method to verify trawl survey results obtained in 2001. Estimation of snow crab biomass from the daily CPUE in CFAs 21 and 22 were obtained according to the method Catch-effort maximum likelihood estimation of important population parameters described by Gould and Pollock (1997). Biomass estimations were calculated for CFAs 21 and 22 northern (combined) and 22 outer (Biron et al. 2001).

Sea sampling

Sea sampling data were collected solely by certified observers and were not adjusted (weighted) in any way. For each randomly-sampled trap, the total number of male crabs, the position, and depth of each trap fished were recorded, and a sub-sample of 20 to 40 crabs was taken randomly for the following measurements: carapace width (CW) and chela height (ChH) using modified vernier callipers (Watson and Wells 1970), carapace hardness of the right claw (CH) using a hardness gauge (Foyle et al. 1989), and carapace conditions (Appendix I; Moriyasu et al. 1998). New-soft (stage I) and clean crab (stage II) with durometer readings <68 were considered to be postmolt soft-shelled crab (Moriyasu et al. 1998). The terminology of male maturity phase follows Sainte-Marie et al. (1995). Adult (terminal molt) and adolescent (non-terminal molt) individuals were identified based on the following discriminant function assigning individuals to the correct groups in 99% of cases (for adult males: $Y > 0$), calculated for ENS male snow crab (Biron et al., 1999):

$$Y = 19.775707 \ln(ChH) - 25.324040 \ln(CW) + 56.649941$$

Estimation of soft and white crab mortality

An experiment aimed at estimating the mortality caused by fishing activities on the recently molted male snow crabs (soft and white) was done in co-operation with a fisherman. In total, 10 commercial traps were fished one at a time to capture soft and white crab needed to prepare 19 experimental traps (1-2 at a time) containing 20 crabs (soft and / or white categories) each. These experimental traps were set on August 21, 2001 in CFA 24. Overall, it took 1.5 hr to fish the commercial traps and to prepare and set the experimental traps. Manipulation of the soft and white crab was kept to a minimum to reduce as much as possible the mortality caused by the stress unrelated to fishing activities, and as a consequence no biological measurements were taken. The operation went as follows: 1- A commercial square trap was brought on board of the vessel; 2- The selected snow crab specimens were handpicked directly out of the trap and placed into 1 or 2 experimental traps with all openings closed by a 40 mm netting; 3- Each trap containing the soft and white crab was returned to sea as soon as possible, usually within 10 minutes. In the case where 2 experimental traps were prepared from the same commercial trap, the crab for the 2nd

experimental trap were kept in tote boxes and under a tarp until the 1st trap was launched. These traps were fished 3 days later on August 24, 2001, and the biological measurements of the snow crab were taken: CW, ChH, CC and CH. Each crab was also categorised as being alive (excellent, good, fair), weak, or dead (Appendix 2).

Exploratory trap survey along the edge of the Scotian Shelf (slope survey)

A systematic trap survey was conducted along the slope area of the Scotian Shelf in order to determine the distribution, catch rates and movement pattern (by tagging) of snow crab. The survey area was located within the offshore portions of CFAs 23 and 24 on the Scotian Shelf slope of Banquereau and Sable Island Banks at depths varying from 100 m to 400 m. No effort was permitted within the Sable Gully protected area. From this protected area, the survey extended northward to 45°00' latitude in CFA 23 and eastward to the 61°00' longitude in CFA 24.

The survey areas were divided into 10 mile sections, within which 2 transects of 1 trap were set at the depths of 100, 200, 300 and 400 m. This was done a minimum of 2 times between July and November 2001, with at least 1-month between each fishing. Selected fishermen were requested to follow the same management measures as for the 'normal' commercial fisheries (i.e. mandatory logbook, hail requirements, 100% dockside monitoring, 25% at-sea observer coverage, etc.). For each trap, the total number of male crabs, the position and depth were recorded, and a sub-sample of 40 crabs was taken randomly for the following measurements: CW, ChH, CC and CH. Additional reporting requirements included a description of catch (i.e. Snow crab, Jonah crab, others). Traps in one of the transect in each section set at the depth of 100 and 400 m had temperature probes. Tagging was conducted during the second part of this experiment.

Mobile gear fishery data

Data on fishing effort and fishing locations of the shrimp fisheries in 2001 were obtained from compiled electronic database maintained by the Invertebrate Fisheries Division and the Marine Fish Divisions of DFO Maritimes Region.

Annual trawl survey

Trawl sampling – A pre-season trawl survey has been conducted since 1997 using a chartered 65' stern-trawler. A Bigouden *Nephrops* trawl was used (20m head line, 27.3 m foot rope mounted with a 3.2 m long, 8 mm galvanised chain, and mesh size of 80 mm in the wings, 60 mm in the belly and 40 mm in the cod-end: Conan et al. 1994). A stratified-random survey was used: one-two locations were randomly chosen within each 10° latitude by 10° longitude rectangle (grid). Once selected, the same stations were used every year while new ones were added randomly. In 1997 there were 150 stations within CFAs 22, 23 and 24. By 2000, the survey had extended to encompass areas of the Cabot Strait, Sydney Bight and most the Scotian Shelf east of NAFO demarcation 4W/4X, with a total of 307 stations. The duration of each tow varied between 5 to 8 minutes at an average speed of 2 knots. The appropriate length of a tow was determined in 1987 (Moriyasu et al. 1998). The *Nephrops* trawl was constructed so that the foot rope digs into the bottom sediment and tows longer than 5-8 min may result in a full load of mud, reduced catchability, and significant net damage. NetMind® sensors monitored net behavior. A Minilog Temperature / Depth sensor was

added in 2001 to compliment other electronic sensors. The onboard starting point for each tow was decided when the predetermined amount of warp was let out and winch drums were locked, while monitoring depth and net height. When both height sensor readings became equal and the depth sensor reached a comparable value to the boat's sounder reading, the tow was officially started. The vessel increased its speed to 2 knots and remained at that speed for 5 minutes. After towing 5 minutes, the engine was put in neutral, the winches were started, and the tow officially ended. In cases of abnormal net behavior or damage, a new tow was completed. Recorded information for each tow were: duration, position at start, mid and end, horizontal opening of the trawl using NetMind®, and water depth. The survey usually commenced at the end of April or early May, and was completed in late June or early July, before the fisheries start. To cover the entire snow crab habitat in eastern Nova Scotia, 30 to 45 sea-days were required. Water depths ranged from 50 to 450 m. All male crab was measured for CW, ChH, CH and CC. Size-frequency histograms were standardised to the surface area swept by the trawl. All female crabs were measured for CW and the width of the fifth abdominal segment. The presence and the color of the eggs were also taken.

Mapping and estimation of abundance by Kriging – Kriging (Matheron 1970; Clark 1979) was used to estimate biomass and map density of different categories crab (Conan 1985; Conan et al. 1988; Conan et al. 1994). Kriging consisted of two procedures: (1) analyzing and modelling the covariance between sampling units as a function of distance using a variogram; and (2) interpolating the densities of crab in unsampled areas by using the covariance function to assign weights to neighbouring samples. Separate variograms and density estimates were made for each sampling unit. Numbers of crab were converted to biomass using a CW-weight relationship, $W = 1.543 \times 10^{-4} CW^{3.206}$ (Biron et al. 1999). Natural mortality between the date of the completion of the survey and the next year's fishing season, 12-14 months later, was unknown and not considered for this exercise.

Projected habitat area (see discussion) – The projected habitat area (PHA) was introduced in 1999 to account for the irregular bathymetry and subsequent bottom temperature profiles, which may render a portion of the area non-habitable for commercial-sized adult males (Biron et al. 2000). The PHA was incorporated into our assessment process by means of "masks", which impose restrictions or boundaries on the interpolation process. The "masks" included a series of zero values, which were positioned onto areas of highly probable zero densities. Different "masks" were used for commercial and non-commercial snow crab categories.

From 1997 to 2000, our assessment process included a pseudo-zero setting (called "mask of zeros") for the commercial portion of the stock by assuming that all grounds with less than a 70m depth had no crab population. In addition to this restriction, snow crab density projections were only made over areas of between 90 and 300 m depths. This area was deemed to represent the region covered by the fishing grounds and a boundary (called "cookie-cutter") was established to limit projections only on those areas. This process was completed in the past to eliminate certain areas from the analysis such as shallow banks, as these areas were thought to have been a major source of overestimation of biomass (Biron et al. 2000). For constructing the size distribution histograms for both northern and southern ENS, data from all stations sampled were used without any mask or cookie cutter.

The new mask of zeros (Fig. 2) was then introduced by considering that all grounds with less than 20 m (previously 70 m) along the shore of mainland Nova Scotia and Cape Breton

Island had zero snow crab density. All grounds with less than 70 m on the Scotian Shelf (i.e. major banks) or deeper than 380 m along the slope of the Laurentian Channel were also considered to be of zero density. The area situated outside the surveyed area in Emerald Basin was also considered to be of zero snow crab density because of relatively warm bottom temperatures (Biron et al. 2001). In addition, the mask in the Misaine Bank area was modified to better reflect the particularities of that region (see discussion).

Starting with 2001, the surface used for Kriging calculations has been fixed according to the same criteria developed in 1999 (Biron et al. 2000). This surface will be 5,000 km^2 in northern ENS and 28,900 km^2 in southern ENS, and will now be referred to as the 'Kriging surface', or simply the surface used for Kriging. The 'cookie cutter' will be used to limit the projection of contour of density maps using the same depth criteria as the mask of zeros.

Morphological maturity - The terminology "adolescent" (small claw) for non-terminal molt males and "adult" (large claw) to represent the terminal molt males (Sainte-Marie et al. 1995) was used. The distinction between the two groups was based on the bivariate discriminant function obtained using CW and ChH relationship (see Sea sampling section).

Total biomass estimation – Between 1997 and 2000, independent variograms (and their resulting biomass estimates) were produced for the recruitment to the fishery (B_{R-1}), for the exploitable biomass (B_e), and also for the total biomass (B_t). In 2000, the RAP committee recommended that estimation of total biomass for any given year is simply equal to the sum of the recruitment and exploitable biomass estimated that given year (Biron et al. 2001). Therefore, the following equation:

$$B_t = B_{R-1} + B_e$$

will determine the total biomass estimate for any given year. The associated confidence intervals will simply be the sum of the confidence intervals determined for B_{R-1} and B_e (both in t) (Cochran 1977).

Seasonality effects experiment in northern ENS – In CFAs 20-22, 30 trawl stations were revisited in September. These extra stations were used to estimate the commercial-sized adult male biomass in the fall for comparison with the biomass estimated from the May 2001 annual survey.

Biological unit versus Management unit – From a scientific perspective, there were two main concentrations of the resource in ENS, one in the north (CFAs 20-22) and the other in the south (CFAs 23-24) (Biron et al. 2000). Further, CFAs in ENS do not reflect biological distribution of the resource and to use these CFAs as a reference point to present the trawl survey results compromises the reliability of the biomass estimates. Therefore, trawl survey results are shown for northern and southern ENS units only.

Originally surveyed area versus Total surveyed area (Biron et al. 2000) – The number of trawl stations sampled has steadily increased from 150 to 322 between 1997 and 2000, and the surface to be covered by the survey is expected to increase again in 2002. Consequently, increasing the total surveyed area renders the comparison of 'total' trawl results very difficult between years. Therefore, trawl data is also compared each year based on the originally surveyed area rather than the total surveyed area until the number of trawl stations sampled

every year stabilises. In southern ENS, the "originally surveyed area" refers to the surface used for kriging in 1997 (17,623 km^2), while in the case of northern ENS, it corresponds to the surface used in 1998 (4,250 km^2).

Temperature – Since 1997, it has been common practice to attach a temperature probe (VEMCO Ltd) to the trawl for each tow. Although temperature data was sent to Hydrologic Services, DFO-Halifax, for proper analysis, some results are briefly discussed in this document.

Annual groundfish trawl survey on the Scotian Shelf

The Marine Fish Division of DFO Maritimes Region has been conducting a stratified random trawl survey of the entire Scotian Shelf in July for over 32 years. At each station a Western IIA trawl was towed for 30 minutes at 3.5 knots towards the next random station (Koeller 1981). The trawl has a 106 foot roller-rigged foot rope and 2000 pound portuguese doors. The cod end was lined with 3/4 inch mesh to retain small fish. Crabs and other invertebrates have not been consistently recorded on these surveys, but since 1999 an effort was made to ensure all crabs were recorded and measured (J. Tremblay, pers. comm.). Some results concerning snow crab were presented for the survey of the entire Scotian Shelf of July 2001.

RESULTS

Fishery

The overall TAC for ENS in 2001 was 9,848 t (10,048 t if slope trap surveys are included) compared to 9,814 t in 2000. Total reported landings in 2001 were 9,917 t (Table 2, Fig. 3). There was a 23% increase in the seasonal CPUE and a 16% decrease in total fishing effort compared to 2000. The seasonal geographic distribution was presented for landings (Fig. 4), CPUE (Fig. 5) and fishing effort (Fig. 6), as well as the location of the logbook positions recorded by fishermen (Fig. 7).

CFA 20

Fishing distribution – As in 2000, permanent fishermen exploited mainly 2 fishing grounds, one located along the snow crab boundary of CFAs 19/20 and the other along the snow crab boundary of CFAs 20/21 (Fig. 7). In 2001 however, some of the effort shifted from the boundary of CFAs 19/20 to the boundary of CFAs 20/21 where most of the permanent fishing effort occurred (4 out of 5 fishermen). Temporary fishermen also concentrated their effort in an area along CFA boundary 20/21, with very little effort remaining around St. Paul Island and along the Snow Crab boundary of CFAs 19/20 compared to 2000. Both permanent and temporary fishermen have pointed out the fact that the minimal effort observed around St. Paul Island was a consequence of strong currents that made fishing impossible, rather than the lack of crab on this fishing ground.

Landings – The TAC remained at 118 t in 2001, the same as in 2000. Total landings in 2001 were 117 t and occurred over a 4 week period (July 23 to August 17), with 85% of the landings occurring within the first 2 weeks of the fishery (Tables 3 and 4). In total, permanent and temporary fishermen landed 68.2 t and 48.4 t respectively.

CPUE and effort - The average CPUE was 64.8 kg/th in 2001, a 37% increase compared to 2000 (46.7 kg/th) (Table 3, Fig. 8). Meanwhile, a 30% decrease in total effort (1,797 trap hauls) was reported in 2001 compared to 2000 (2,543 trap hauls) (Table 4c, Fig. 9). The 2001 seasonal CPUE of permanent license holders of 92.9 kg/th was almost 60% higher than in 2000, while the total effort reported of 739 trap hauls was 30% lower than those of 2000 (1,202 trap hauls). The temporary license holders have reported a seasonal CPUE of 45.7 kg/th in 2001, an increase from their 2000 CPUE of 35.8 kg/th, while the total effort of 1,059 trap hauls represented a decrease over those of 2000 (1,383 traps hauls) (Table 4). The temporary seasonal CPUE average of 45.7 kg/th did not include the first 2 fishing trips of the 2 fishermen (out of 6), which were fishing around St. Paul Island at the time, but obtaining very low daily CPUE (± 5 kg/th). Both fishermen moved towards the 20/21 boundary after the second trip where their average CPUE became comparable to those of other temporaries fishing this area.

At-sea sampling by observers - The 2001 catches composition showed that 80% of the measured crabs were commercial-sized adult males (Table 5a and Table 1a in Appendix 3), compared to 74% in 2000. Adolescent males accounted for 5% of the catches in 2001 (8% in 2000). There was 1.2% soft-shell crab captured compared to 5.4% in 2000. The proportion of adult males (<95 mm CW) was 15.2% in 2001 (18.3 % in 2000). The mean CW was 105.1 mm CW (Figs. 10), a slight decrease compared to 107.3 mm CW in 2000. Overall, 4 trips were covered by certified observers for a total of 16 traps sampled and 420 crabs measured (in 2000; 3 trips, 11 trap, N=428). The seasonal CPUE estimated from the 16 traps sampled in CFA 20 in 2001 was 58.7 kg/th. In 2001, the minimum average CPUE per trip observed was 4.8 kg/th and the maximum was 138.4 kg/th. The locations of all traps sampled in CFA 20 by the at-sea observer program in 2001 were shown in Figure 11.

CFA 21

Fishing distribution – The fishing occurred exclusively in the near shore area, in the trough commonly shared with the northern part of CFA 22 and part of CFA 20 (Fig. 7).

Landings - The TAC was 363 t in 2001, the same as in 2000. Total landings in CFA 21 were 363 t (Table 6). Officially, landings occurred from July 23 to August 20, 2001, but overall 97% of the landings occurred during the first 2 weeks (Table 7).

CPUE and effort – The seasonal CPUE of 93.4 kg/th in 2001 represents a 50% increase compared to 2000 (62.1 kg/th) and the highest value recorded since 1978 (Table 7, Fig. 8). The effort (3,888 trap hauls) decreased by 34% compared to 2000 (Table 7, Fig. 9).

At-sea sampling by observers - The soft-shell crab percentage was 10% in 2001 (17% in 2000) (Table 5b). Adolescent males represented 62% of the catch composition in 2001, compared to 16% in 2000. The proportion of adult males <95mm CW was 4 % in 2001 (14% in 2000). The mean CW of at-sea samples in 2001 was 104.7 mm (Fig. 10) compared to 106.7 mm in 2000. In 2001, 7 trips were covered by certified observers for a total of 13 traps sampled and 520 crabs measured (in 2000; 10 trips, 28 trap, N=1,120)(Table 1b in Appendix 3). The seasonal CPUE estimated from the 13 traps sampled in CFA 21 in 2001 was 85.0 kg/th. In 2001, the minimum average CPUE per trip observed was 41.9 kg/th and

the maximum 278.8 kg/th. The locations of all traps sampled in CFA 21 by the at-sea observer program in 2001 were shown in Figure 11.

CFA 22

Fishing distribution – As in previous years, the fishing effort was concentrated in 2 distinct fishing grounds: 1- the near shore trough commonly shared with CFA 21 and part of CFA 20 (sub-area 22 northern), and: 2- the outer area known as Glace Bay Hole (sub-area 22 outer) (Fig. 7).

Landings – The TAC was 585 t in 2001 (318 t for the northern group and 267 t for the southern group), representing a 50 t increase in CFA 22 outer compared to 2000. However, since 3 fishermen passed from CFA 22 northern to CFA 22 outer in 2001, most of the increase in the resulting IBQ was actually felt in CFA 22 northern. In 2001, IBQs increased from 13,834 to 15,900 kg in CFA 22 northern and from 15,422 to 15,706 kg in CFA 22 'outer' (Table 1). In 2001, in the northern portion, 20 fishermen landed 319 t within 3 weeks, while 17 fishermen landed 268 t during the same period in the outer area, for total landings of 586 t (Tables 8 and 9). Overall, 70% of the landings occurred during the first week (65% northern, 78% outer).

CPUE and effort - The average seasonal CPUE of 105.1 kg/th was 28% higher than that of 2000 (Table 8, Fig. 8). The average seasonal CPUE in 2001 was 87.9 kg/th for the northern area (68.6 kg/th in 2000) and 135.9 kg/th in the outer area (106.0 kg/th in 2000) (Table 9, Fig. 8). Total effort for CFA 22 in 2001 (5,577 trap hauls) was 18% lower than 2000 (6,803 trap hauls) (Table 9, Fig. 9). In 2001, the breakdown shows that the seasonal effort for the northern area was 3,625 trap hauls, and 1,976 trap hauls for the outer area (Table 9).

At-sea sampling by observers – Overall, the soft-shell crab percentage was 6% in 2001 (14% in 2000) (Table 5c). Adolescent males represented 3% of the catch composition in 2001 compared to 23% in 2000 (Table 5c). The proportion of skip molters was 2.4% in 2001 (19% in 2000). The mean CW of at-sea samples in 2001 was 104.7 mm (Fig. 10) compared to 102.5 mm in 2000. The proportion of adult males <95 mm CW was 20 % in 2001 (15% in 2000). In 2001, 8 trips were covered by certified observers for a total of 40 traps sampled and 1,600 crabs measured (in 2000; 12 trips, 58 trap, N=2,300) (Table 1c in Appendix 3). The seasonal CPUE estimated from the 40 traps sampled in CFA 22 in 2001 was 141.1 kg/th. In 2001, the minimum average CPUE per trip observed was 74.2 kg/th and the maximum 339.0 kg/th. The locations of all traps sampled in CFA 22 by the at-sea observer program in 2001 were shown in Figure 11.

CFA 23

Fishing distribution – Fishing effort and distribution in 2001 was influenced by the sub-area boundaries which were introduced in 2000 to control the fishing effort associated with the increase in the TAC in CFA 23, and by the "gentlemen's sharing agreement" reached with the shrimp fishermen concerning the sharing of mutual fishing grounds. In this latter case, some areas of CFA 23 were closed to the crab fishery for part of the year, and vice-versa. Permanent fishermen have mainly fished in sub-area 23A and 23B, while temporary fishermen have fished their respective sub-area (23B, 23C and 23D) (Fig. 7). New in 2001 were the commercial exploitation of an area situated along the slope of the Scotian Shelf by

temporary fishermen of 23D, which represented 32% of the total landing in that sub-area, and the exploratory trap survey done by 2 vessels also along the slope of the Scotian Shelf (Fig. 15).

Landings – There was an increase in TAC from 4,425 t in 2000 to 4,789 t in 2001 in CFA 23. Permanent license holders captured 1,778 t and temporary permit holders landed 3,105 t (excluding the landings from the trap survey) for total landings of 4,805 t (Tables 10 and 11). Landings occurred from June 1 to mid-December, with more than 50% of the landings caught in June and July alone (compare to 75% in 2000). In 2001 however, only area 23D opened on June 1st and all other sub-areas started on July 1st (Table 1), while all sub-areas had started on June 1st in 2000.

CPUE and effort - The averaged seasonal CPUE of 82.6 kg/th in 2001 was comparable to 2000 (85.0 kg/th) (Table 10, Fig. 12). The total effort was 58,959 trap hauls in 2001 (51,734 trap hauls in 2000)(Table 11, Fig. 13). In 2001, the seasonal CPUE of permanent license holders was 112.6 kg/th (103.4 kg/th in 2000), while total effort was 15,719 trap hauls (16,857 trap hauls in 2000)(Table 11). Temporary fishermen had seasonal CPUEs of 97.0 kg/th in sub-area 23B, 143.7 kg/th in 23C and 50.9 kg/th in 23D (Table 11), compared to 93.8 kg/th, 87.1 kg/th and 60.0 kg/th, respectively, in 2000. In sub-area 23D, the highest catch rate was found in the slope area (59.9 kg/th), followed by the gully area (50.8 kg/th) and the Artimon area (44.9 kg/th) (Table 12).

At-sea sampling by observers – Overall, adolescent males represented 16% of the catch composition in 2001 compared to 12% in 2000 (Table 13). A breakdown by sub-areas show the level of adolescent males at 13.6% in 23A, 17.2% in 23B, 6.5% in 23C and 16.5% in 23D (Table 13). The proportion of skip molters in CFA 23 was 13% in 2001 (9.6% in 2000). On a sub-area basis, the proportion of skip molters in 2001 was 11.1% in 23A, 14.1% in 23B, 4.9% in 23C and 13.9% in 23D. The proportion of adult males <95mm CW in 2001 was 8.4% for the CFA (4% in 2000), 12.1% in 23A, 7.6% in 23B, 16.4% in 23C and 6.1% in 23D. The mean CW of at-sea samples in 2001 was 109.6 mm (Fig. 10) compared to 108.8 mm in 2000. In 2001, 78 trips were covered by certified observers for a total of 638 traps sampled and 25,131 crabs measured (in 2000; 46 trips, 356 traps, N=13,475) (Table 2 in Appendix 3). The seasonal CPUE estimated from the 638 traps sampled in CFA 23 in 2001 was 117.4 kg/th. The minimum average CPUE per trip observed in 2001 was 31.0 kg/th and the maximum 358.5 kg/th. The locations of all traps sampled in CFA 23 by the at-sea observer program in 2001 were shown in Figure 11.

The seasonal percentage of soft-shell crab for CFA 23 was 13.2% of total catches in 2001 (5% in 2000), while it was 14.3% in 23A, 20.7% in 23B, 2.1% in 23C and 4.9% in 23D (Table 14). From a CFA perspective, higher weekly levels of soft shell crab (i.e. 20% or more) were observed after 10 to 12 weeks into the fishing season in 2001, but one must remember that sub-area 23D started almost 5 weeks earlier than all other sub-areas that year (Table 14, Fig. 14). From a sub-area basis, the percentage of soft-shell crab was generally low during the 4 to 6 weeks following the respective opening day, to rapidly increase to levels above 20% by the 6th to 8th week (Table 14, Fig. 14).

CFA 24

Fishing distribution – Fishing effort and distribution in 2001 was influenced by the sub-area boundaries which were introduced in 2000 to control the fishing effort associated with the increase in the TAC in CFA 23, and by the "gentlemen's sharing agreement" reached with the shrimp fishermen for the sharing of mutual fishing grounds. In this later case, some areas of CFA 24 were closed to the crab fishery for part of the year, and vice-versa. Permanent fishermen have mainly fished in sub-area 24A, while temporary fishermen have fished their respective sub-area (24B, 24C, 24D and 24E) (Fig. 7). New in 2001 was the exploratory trap survey done by 2 vessels along the slope of the Scotian Shelf (Fig. 15).

Landings – There was a reduction in TAC from 4,374 t in 2000 to 4,061 t in 2001 in CFA 24. Permanent license holders captured 1,654 t and temporary permit holders landed 2,547 t (excluding the landings from the trap survey), for a total landed of 4,043 t (Table 15 and 16). Landings occurred from June 1 to December, with more than 50% of the landings caught in June and July. In 2001, area 24D opened on June 1st and all other sub-areas started on July 1st (Table 1).

CPUE and effort – The seasonal CPUE of 96.2 kg/th was almost 15% higher than in 2000 (84.9 kg/th) (Table 15, Fig. 12). The total effort was 44,080 trap hauls in 2001 (49,813 trap hauls in 2000) (Table 15, Fig. 13). The 2001 seasonal CPUE of permanent fishermen (116.0 kg/th) was 33% higher compared to 2000 (87.5 kg/th), while their total effort was 14,482 trap hauls in 2001 (19,315 trap hauls in 2000). Temporary fishermen had seasonal CPUEs of 122.6 kg/th in sub-area 23B, 94.1 kg/th in 23C, 83.7 kg/th in 23D and 65.4 kg/th in 23E (Table 16), compared to 96.8 kg/th, 85.5 kg/th, 80.1 kg/th and 50.1 kg/th, respectively, in 2000. In 2001, some commercial exploitation of the slope area in CFA 24 occurred during the exploratory trap survey. In this case, the remaining portion of the quota after the completion of the directed trap survey could be fished anywhere, as long as it remained on the slope area. The highest catch rate was found in the slope area (101.5 kg/th), followed by the area north of Sable Island (82.6 kg/th) (Table 17).

At-sea sampling by observers – In 2001, adolescent male crabs represented 24% of the catch composition in CFA 24 compared to 19% in 2000 (Table 18). A breakdown by sub-areas showed the level of adolescent males at 21.2% in 24A, 19.6% in 24B, 6.7% in 24C, 33.9% in 24D and 10.6% in 24E (Table 18). The proportion of skip molters in CFA 24 was 21.3% in 2001 (17.2% in 2000). On a sub-area basis, the proportion of skip molters in 2001 was 18.9% in 24A, 18.4% in 24B, 4.4% in 24C, 29.5% in 24D and 9.5% in 24E. The proportion of adult males <95mm CW in 2001 were 8.9% for the CFA (7% in 2000), 10.0% in 24A, 3.9% in 24B, 9.2% in 24C, 5.1% in 24D and 19.9% in 24E. The mean CW of at-sea samples in 2001 was 108.7 mm (Fig. 10) compared to 111.7 mm in 2000. In 2001, 60 trips were covered by certified observers for a total of 532 traps sampled and 21,155 crabs measured (in 2000; 41 trips, 376 traps, N=14,694)(Table 3 in Appendix 3). The seasonal CPUE estimated from the 532 traps sampled in CFA 24 in 2001 was 108.9 kg/th. The minimum average CPUE per trip observed in 2001 was 30.9 kg/th and the maximum 340.1 kg/th. The locations of all traps sampled in CFA 24 by the at-sea observer program in 2001 are shown in Figure 11.

The seasonal percentage of soft-shell crab for CFA 24 was 13.6% of total catches in 2001 (4.4% in 2000), while it was 20.9% in 24A, 4.3% in 24B, 13.6% in 24C, 8.0% in 24D and

7.7% in 24E. From a CFA perspective, higher weekly levels of soft shell crab (i.e. 20% or more) were observed 10-11 weeks after the start of the fishing season in 2001, but 24D started almost 5 weeks earlier than all other sub-areas that year (Table 19, Fig. 14). Percentage of soft-shell crab was relatively low throughout the whole fishing season in all sub-areas, except for 24A, which rapidly increased to nearly 20% by the third week (Table 19, Fig. 14).

Biomass estimates in CFAs 21 and 22 based on the catch-effort information

In 2001, the catch-effort analysis estimates of the snow crab biomass at the beginning of the fishery were 1,508 t in CFAs 21 and 22 northern (combined) and 449 t in CFA 22 outer (Table 20).

Mobile gear fisheries

Total seasonal effort in the shrimp fisheries in 2001(12,328 hrs) was 8% lower than in 2000. Monthly results showed that effort applied during the summer time in previous years had shifted to the fall season in 2001, although most of the fishing occurred from April to June as in 1999 and 2000. The shift in effort from the outside to the nearshore that has been occurring since 1998 was again observed in 2001 (Appendix 4).

Estimation of soft and white crab mortality

Weather conditions during trap setting (1st day) consisted of an overcast sky with an ambient temperature of 18°C. After the 3 days set, there were 14 traps with 20 crabs, 3 with 17 crabs and 2 with 19 crabs, for a total of 19 traps containing 369 crabs. It was presumed that 11 crabs have escaped from the traps between August 21 and 24, and are not being considered in this analysis. Of the 369 crabs measured, one crab had a durometer reading of 90 and a carapace condition of 3 (i.e. being neither soft nor white) and was eliminated from further analysis.

Overall, there were 308 soft crab ($N_{(soft)}$=308) and 60 white crab ($N_{(white)}$=60) considered in the analysis, and each category consisted of 257 adults + 47 adolescents (with 4 unknown) and 55 adults + 5 adolescents, respectively. After 3 days, it was found that 84% of the soft-shell crabs were alive (excellent, good, fair), 12% were considered extremely weak and 4% were dead (Table 21). In the case of the white crab, 95% of the crabs were considered alive, 3% were extremely weak and 2% were dead (Table 21). The combination of the weak and dead categories was considered as minimum mortality caused by the fishery. The mortality rates would therefore be 16% ± 4.1% for soft-shell crab and 5% ± 5.5% for white crab.

Exploratory trap survey along the edge of the Scotian Shelf

In CFA 23, the distribution of the fishing set's positions with snow crab versus those without (Fig. 15) showed that snow crab were found mainly at the shallowest locations. The mean number of crab by depth range for all traps combined (i.e. regardless of month sampled) was highest at 75-150 m, and decreased rapidly with depth (Table 22). The highest numbers per tow coincided with the commercial fishing areas on the slope. The mean numbers of crab per trap for the 2nd trap survey was lower everywhere compared to the 1st trap survey, a month or so earlier (Table 23).

Annual groundfish trawl survey on the Scotian Shelf

Overall, 201 stations were sampled during the July 2001 groundfish trawl survey that covered the Bay of Fundy and all of the Scotian Shelf. All but 4 of the 72 stations with snow crab were found east of the 62° longitude, i.e. in the north-east Scotian Shelf, while the 4 stations with low numbers of crab were found near shore in central and southwest Scotian Shelf (Fig. 16). The distribution map shows the number of snow crab per standard tow (adjusted for tow length).

Annual trawl survey

Snow crab biomass trawl surveys have been conducted in ENS each year since 1997. The 2001 survey for ENS was carried out between April 26 and July 20. A total of 303 trawl stations were completed in CFAs 20-24, which encompassed areas of the Cabot Strait, Sydney Bight and Scotian Shelf (Fig.17). The total area covered for biomass estimation by kriging was approximately 34,000 km^2 in 2001. The different variograms used in the kriging calculations indicate that there is a covariance effect between the values sampled ranging from 10 to 90 km. There were 7,296 males and 2,852 females collected and measured in 2001 compared to 9,647 and 4,039 in 2000, respectively.

Along with the usual complications throughout the survey of damaged trawls, equipment malfunctions, bad weather, etc., we also encountered the additional problem of changing vessels. There was a delay of nearly a month because the chartered survey vessel (the Marco Brittany), which was usually used, was sold and the replacement vessel was still under construction (the Marco Michel). After the new vessel (Marco Michel) arrived and was equipped to do the survey, a comparison survey was conducted which consisted of revisiting the last 25 tows made by the old vessel. These 25 tows are not included in the above total of 303 trawl stations and were not used for biomass estimation. Several glitches with the new vessel (Marco Michel) were experienced, including serious stability problems. This consequently led to the decision to terminate work on this vessel. A third vessel (Den C. Martin; used to conduct the southern Gulf trawl survey) was incorporated to complete the survey in ENS.

A breakdown of tows by each vessel is as follows:

26/04/01 – 25/05/01	164 tows (Marco Brittany)
21/06/01 – 23/06/01	25 comparison tows (Marco Michel)
23/06/01 – 05/07/01	48 tows (Marco Michel)
12/07/01 – 20/07/01	91 tows (Den C. Martin)
21/09/01 – 25/09/01	30 revisited tows (Marco Michel)

Northern ENS

Overall in northern ENS, the number of trawl stations sampled during the annual trawl survey in May 2001 was 69 (64 in 2000). The trawl stations were distributed within 45 grids (10°x10°) at a rate of 1 to 2 per grid. Ten stations were added along the outside limit of the 2000 surveyed area, extending the surveyed area to cover the slope of the Laurentian Channel to depths of up to 450 m (Figure 17). These 10 stations were comprised of 5 new stations and 5 existing stations in 2000 that were redistributed in 2001. All trawl stations

were surveyed from April 26 to May 10, 2001, before the fishing season. There was no change in the trawl survey vessel compared to 2000. The estimated total area covered for biomass estimation by kriging in northern ENS was 5,000 km^2 in 2001 (4,820 km^2 in 2000).

The 30 trawl stations sampled during the experimental trawl survey in September 2001 were distributed within 30 grids (10°x10°) (Fig. 18). All trawl stations were surveyed between September 21 and 25, after the fishing season. The total area used for biomass estimation in September was the same used in May 2001 (5,000 km^2).

In May 2001, the total biomass estimation for commercial-sized adult male was 2,930 ± 931 t, and was comprised of 25 ± 194 t of soft shell and 2,905 ± 737 t of hard shell crab (Table 24). Biomass estimated from the September survey gives a total biomass for commercial-sized adult males of 3,982 ± 1,691 t, and was divided into 1,532 ± 494 t of soft-shell and 2,450 ± 1,197 t of hard shell crab (Table 24). Considering the 1,065 t landed in northern ENS before the September survey, the estimated biomass of hard shell crab just prior to the fishery should have been 3,515 t (2,450 t in Sept. + 1,065 t) (Table 25).

The density distribution maps of adult male (CW ≥ 95 mm) showed that while no appreciable amount of recruitment was found in the May trawl survey, the recruitment was clearly present in area 22 during the September survey (Fig. 19). Hard shell adult males were mostly found in CFA 21 during the May survey and in CFA 22 (Smoky Bank area) in September (Fig. 19).

Comparison of the size-frequency histograms (derived from all the tows sampled each year) showed that the mean density (in number) of juvenile and adolescent males has been decreasing each year since the complete northern ENS survey started in 1998 (Fig. 20). Comparison of the estimated total population (in number) in the originally surveyed area also showed that male pre-recruits have been decreasing since the survey started in 1998, while the mature females have dramatically decreased in number since 1999 (Fig. 21). During the same period, the number of commercial-sized adult males seems to have remained more or less constant (Fig. 21).

Southern ENS

In southern ENS, 234 trawl stations were surveyed in 2001 compared to 253 in 2000 (included were 10 experimental stations not repeated in 2001). Ten experimental stations situated on Misaine Bank and 20 stations located in Emerald Basin were eliminated in 2001, but 10 new stations were added near shore in the western limit of CFA 24E (Fig. 17). The first 95 trawl stations of 2001 in southern ENS were completed using the Marco-Brittany between May 8 and May 25, and covered most of sub-areas 23A and 24A, parts of 23B, 23C and 24B, and all of 23D and 24D (Fig.22). The next 47 trawl stations (not considering the 25 stations done for vessel comparison) were done with the Marco-Michel between June 21st and July 5th, and covered the remaining stations in sub-areas 23A, 23B and 23C, and part of 24A (Fig. 22). The last 92 trawl stations of the survey were conducted with the Den-C Martin between July 12 and July 20, and covered parts of Area 23 (5 stations) and sub-area 24A, most of 24B, and all of 24C and 24E (Fig. 22). No valid vessel comparison was done. The estimated total area used for biomass estimation by kriging in southern ENS has increased to 28,910 km^2 in 2001 (27,312 km^2 in 2000).

Total biomass of commercial-sized adult males was estimated at 33,139 ± 6,464 t in 2001 (Table 26). It was comprised of 8,541 ± 3,500 t of soft-shell and 24,597 ± 2,964 t of hard shell crab (Table 26). Density distribution maps showed that in 2001 the commercial-sized soft-shell crabs were mostly found in sub-areas 23A and 24A (Fig. 23). Commercial-sized hard shell crabs were more predominant in and around sub-area 23B, although smaller concentration patches were found in all sub-areas (Fig. 23).

Comparison of the size-frequency histograms (derived from all the tows sampled each year) showed that the mean density (in number) of juvenile and adolescent males has been decreasing each year since the survey started in 1997 (Fig. 24). Comparison of the estimated total population (in number) in the originally surveyed area showed that male pre-recruits have been decreasing since 1998, while the mature females have been dramatically decreasing in number since 1997 (Fig. 25). During the same period, the number of commercial-sized adult males seems to have remained more or less constant (Fig. 25).

Snow crab distribution

The commercial-sized adult males in 2001 showed a patchy distribution in most sub-areas (Fig. 26). From 1997 to 2000, the highest density and largest concentration patches of commercial-sized adult soft shell males have always been observed in and around sub-area 23B, mostly in the Misaine Bank area and in the trough separating Misaine from Banquereau Bank (Fig. 27). In 2001, smaller concentrated patches of commercial-sized adult soft-shell males were mostly observed in sub-areas 23A and 24A. Except for 1997, the majority of commercial-sized adult hard shell males seem to be found in sub-areas A and B of CFAs 23 and 24 (Fig. 28). In 1997, adult hard shell males were mostly found in 24B/D, but the survey coverage in CFA 23 was limited that year.

In 2001, the density distribution maps of adolescent male with CW ≥ 56 mm and CW ≥ 76 mm showed a patchy distribution located mostly in the Misaine Bank area, but also along the shore and north of Sable Island (Figs. 29 and 30). In both cases, distribution maps showed a steady decline in density since 1997/98 (Figs. 29 and 30).

In 2001, high density concentration of mature females were only observed north of Sable Island, in CFA 24E and in CFA 21 (Fig. 31). This represented a major decrease in distribution compared to 1997/98 (Fig. 31). High density concentrations of adolescent females were mostly found in CFAs 23A, 23B and 24A in 2001 (Fig. 32).

Temperature distribution from the trawl surveys

In 2001, temperature data collected during the trawl survey showed that the coldest bottom temperatures were encountered on Smoky Bank (-0.5 to 0.75°C), while most of the remaining grounds surveyed in northern ENS was between 1 to 3°C (Fig. 33). In southern ENS, temperature data was similar to 2000, with cold water temperature recorded in most areas east of French Bank and along the shore in sub-areas 24C and 24E. The warmest temperatures were recorded in the southwestern portion of CFA 24 (Emerald Basin, Sable Is. Bank).

DISCUSSION

The fisheries and fishery related data

Preliminary analyses showed an increase in average soak time in some areas, but as in 2000, catch rate was not adjusted for soak times (Biron et al. 2001). CPUE's were affected by the change of gear that continued in 2001, the new fishing season in southern ENS (i.e. June 1st for sub-areas D, July 1st for all others), as well as impact from seasonality and other fisheries (Biron et al. 2001). The increase in the CPUE trend and high catch rates in 2001was real, especially in northern ENS (Glace Bay Hole). Record CPUEs from logbooks in 2001 were corroborated by at-sea sampling in 2001.

CPUE and fishing effort in ENS were fairly well distributed among all the available fishing grounds in 2000 regardless of the fishermen's status or any specific fishing area (Fig. 34). Differences among fishing areas seems to be a fair reflection of the differences in gear type, concentration of fishing effort in given areas, and / or density of crabs on the exploited grounds. In northern ENS, the area around St. Paul Island (#1) was quickly abandoned in 2001 because the tide and current were too strong for the gear to fish properly (mean CPUE of 5.4 kg/th). All but 3 of the fishing grounds saw their mean CPUE increase compared to 2000. Decreases were seen in 23B (#8), Artimon (#9), and Gully (#12) areas (Fig. 34).

At-sea sampling

In 2001, at-sea sampling in northern ENS was limited because of the shortness of these fisheries (in sea-days) combined with the high density of crab on the fishing grounds. The year 2001 had by far the best at-sea sampling coverage ever completed in CFAs 23 and 24 in terms of distribution of the coverage in relation with landings, length of the fishing season, and all the sub-areas that had to be sampled. Estimated CPUEs (by trap, trip or sub-areas) based on the at-sea sampling have validated the CPUEs derived from the logbook. This exercise has also validated our custom of automatically rejecting the number of traps on a logbook if the average CPUE is higher than 350 kg/th for high cone traps and 300 for all other types.

Overall in southern ENS, the weekly soft shell crab percentages, derived from the observer coverage, slowly increased during the first 10 to 12 weeks to 20% and more, and had returned to levels under 20% by the 20th week. This could be misleading because the fisheries in sub-areas 23D and 24D actually started 5 weeks earlier than any other sub-areas (Fig. 14). Taken one by one, weekly soft shell percentages seemed to indicate different trends for each sub-area; going from a rapid increase (CFA 24A) to always remaining under 10% (CFA 24B). Although the year 2001 was by far the best at-sea observer coverage ever completed in CFAs 23 and 24, the coverage was too thinly spread to produce meaningful results on a combined weekly and sub-area basis.

In some instances, such as the western portion of sub-area 24D, high levels of soft shell crab observed during the at-sea sampling (>30%) corresponded with the presence of a high proportion of newly molted crab observed from the trawl survey in that same area. High level of soft-shell crab in a given area may also be indicative of a high level of fishing effort.

Implications of mobile gear on snow crab fishery

Mobile gear might be a mixed blessing for the snow crab fishery (Biron et al. 2000). There is the negative and yet to be quantified impact on the benthic habitat and communities, including the direct negative impact on snow crab such as mortality, damaged shell, etc. There might also be a short term positive impact to the mobile gear fleets disturbance of the bottom which has the potential to attract an influx of snow crab, and therefore increase the density of crab over what would have been present otherwise if the grounds had remained undisturbed. The hypothesis is that for certain areas, and if the scale is large enough, disturbed grounds might act as centres of attraction concentrating crabs that would otherwise have been less dense and more disperse. In 2001, as in recent years, most of the mobile gear activities on the Scotian Shelf were conducted by the shrimp fishery.

The relationship between the shrimp fishery and the snow crab fishery, if any, is not clear. Before 1998 in CFAs 23 and 24, there was no effort by the shrimp fishery nearshore (excluding the trap fishery), nor too much activity by the snow crab fleet where the shrimp was concentrated further offshore. Since 1998, the averaged seasonal effort by the shrimp fishery has remained similar, but the effort has been concentrating (shifting) nearshore (Bad Neighbour Shoal), while increased effort in the snow crab fishery has now spread to the outside edge of the Scotian Shelf. The concentration of the shrimp fishery effort toward the near shore was again observed in 2001. As in 2000, and by gentlemen's agreement, some fishing grounds in ENS were reserved exclusively to the shrimp fishery for a given period of time, therefore leaving areas out of reach to the snow crab fishery, especially at the beginning of the season. Also noted in 2001 was the reduction in effort from the shrimp fishery during the bulk of the snow crab fishery, and the apparent redistribution of that effort after most of the crab fishery was done.

Annual trawl survey and Biomass estimations

The impact of changing from one 65' stern trawler to another 65' stern trawler on the biomass estimation process should be minimal, as opposed to the southern Gulf that changed from a side trawler (which has to make a U-turn to unload the net before the start of each station) to a stern trawler. This is especially true considering all the NetMind sensors that are measuring the behavior of the net and determining the swept surface for each station. However, the delay of nearly 1 month between the 1st and the 2nd vessel may have had an impact by giving time for snow crab to move around (in and/or out of the area not surveyed yet). Furthermore, part of the survey in CFA 24 occurred during the fishery in July. Although attempts were made to cover all principal fishing grounds before the fishing activities began, 7 trawl stations were moved from their original position because of the presence of snow crab gear in the water.

The addition of a new depth probe on the net in 2001 has permitted us to better establish the starting point of the trawl station (the moment the net touches bottom), resulting in a more accurate estimate of the swept surface. Overall, this represented an increase between 0 to up to 20% of the surface sampled for each station trawled when compared to previous determination of the swept surface. In southern ENS, the total surface surveyed, although similar in value to 2000, was modified by the removal of 20 stations from the offshore side of Emerald Basin and, the further redistributing of them along the shore in sub-area 24E and in CFA 4X. The 20 stations completed in 2000 in Emerald Basin did not have any commercial-

sized snow crab, probably because of the warm water factor, while in 2001 the new stations along the shore (an area already being exploited by 2 fisheries) had snow crab.

A uniform biomass estimation methodology for both regions does not work because each area is influenced by different problems (Biron et al. 2001). In northern ENS, biomass estimates are influenced by problems that are dynamic in nature (i.e. movement, timing), while estimations in southern ENS are influenced by problems that are physical / environmental in nature (i.e. topography, temperature). Therefore, different approaches were adopted this year (2001) between northern and southern ENS by using area specific projected habitat surface to estimate snow crab biomass. In northern ENS, the mask of zeros that was modified in 2000 now takes into account all the grounds between 20 and 380 meters in depth, with no exceptions made for Smoky and St Ann's Banks. In southern ENS, the mask of zeros modified in 2001 now takes into account all the grounds between 20 and 380 meters deep, but exceptions are made to the major banks (grounds above 70 m = zero) and the offshore side of Emerald Basin that is not covered by the survey (=zeros). One of the major changes in southern ENS has occurred for the Misaine Bank area, in that, contrary to any other major bank in ENS, it is not a well defined bank but rather riddled with deep troughs separated by narrow band of 'banks'. It was made clear in previous research documents that the Misaine Bank area was being grossly underestimated because the old mask of zeros was overriding stations containing high densities of snow crab (Biron et al. 2001). Until now, this area had been treated like any other bank by covering a large area with zeros, without regards to any existing snow crab habitat such as the troughs (Fig. 2). In 2001, the Misaine Bank area was redefined by only choosing locations on some of the bigger "narrow band of banks" to be designated as stations with pseudo-zeros. This allowed all the trawl stations sampled in that area to be considered for kriging, while grounds above 70 m are still being covered with zeros (Fig. 2). As in previous years, estimations of commercial-sized adult crabs were based on the potentially exploitable commercial fishing surface developed in 1999 in collaboration with snow crab fishermen for both northern and southern ENS (Biron et al. 2000).

Snow crab distribution versus trawl survey

Surveyed area - The snow crab abundance from the July 2001 annual groundfish trawl survey confirmed that, except for the slope area in southern ENS and CFA 4X in SWNS, the ENS 2001 annual snow crab trawl survey covered all the grounds where snow crab were likely to be found in ENS. Although not comparable in terms of gear used, trawling procedures followed, and number of snow crab sampled, the groundfish trawl survey is a nice complement to the snow crab survey, even if only to cross-check the results in the surveyed area. The advantage is that this survey is conducted immediately after the snow crab survey (i.e. very little time for movement) and covers the whole Scotian Shelf. The presence of crab on the slope area was confirmed by the experimental trap survey, and in 23D, by the commercial fishery, which captured 1/3 of the TAC allowed in that area (minimal capture in 2000, none reported before).

Seasonal effects - Information presented here is based on an experiment currently in progress in northern ENS. Overall, 30 of the 69 trawl stations sampled in May 2001 were revisited in September 2001, and the same 30 stations will/should also be sampled in January, May, July and Sept. 2002. Preliminary results showed differences between biomass estimates obtained from the May survey with those from September. It seems the survey in May missed the recruitment category altogether, and the prediction of this category of crab is primordial in

establishing future exploitable biomass. Ten extra tows conducted in the Laurentian Channel in May 2001 did not show the presence of any recruitment or hard shell crab in that area. The density distribution map for September clearly shows a high density patch of adult soft shell crab in CFA 21 and 22 northern, on the near shore side of the trough. Therefore, this may indicate that most of the recruitment is predominantly distributed near shore and other areas not trawlable during the May survey. In early May, cold water is present everywhere in northern ENS, from the deepest bottom to the shoreline. It has been shown in the northern Gulf that part of the snow crab population will migrate to shallower water in late winter/early spring to molt and to mate, and move back into deeper water as the water temperature increase (Sainte-Marie and Hazel 1992; Lovrich et al. 1995). Lobster fishermen have been reporting snow crab in their lobster gear in early May at depths as shallow as 7 fathoms. This may indicate the occurrence of the same phenomenon in northern ENS. Crab movement from outside the area may also be a factor.

The difference in the biomass estimates of commercial-sized adult hard shell crabs between the two survey results is not as obvious as the simple difference of 450 t observed between the two surveys (2,905 t in May, 2,450 t in Sept.). There were 1,065 t landed in July, between the two surveys, and these were mainly commercial-sized hard shell crabs. Therefore, one may stipulate from the September survey results was that the biomass for hard shell before the fishery should have been much higher. Considering that the September survey result showed the remaining biomass after the commercial fishery, the pre-season biomass can be estimated as the sum of the remaining biomass and landings (i.e. 2,450 t + 1,065 t = 3,515 t). There is only a 20% difference between the May survey estimate and the 3,500 t estimated for July, prior to the fishery, which may be taken as an indication this category of crabs have been properly estimated during the spring survey. The 20% difference may be caused by a portion of the hard shell crab distributed outside of the surveyed area in May, as the case for most of the soft-shell crab. However, tagging experiment results from 2000 and 2001 suggest that movement inside and outside northern ENS is also an important factor to be considered in that region, (see discussion on movement). Overall, the biomass estimate of commercial-sized hard shell crab from the survey in May was more accurate than for the recruitment category.

Effect of survey timing on annual biomass estimates - The possibility that the May 2001 survey in northern ENS missed the soft-crab altogether because of seasonal movement associated with molting behavior, combined with juveniles preference for colder water (Slizkin 1982) found near shore in late winter/early spring, made us re-evaluate the timing of the survey. In northern ENS, the 1998 survey results showed the highest biomass of soft-shell at 8,210 t (including 6,500 t found in Glace Bay Hole), but was also the year with the latest start date (May 20). In contrast, the record low soft shell biomass of 25 t in 2001 coincided with the earliest starting date (April 26). Therefore, the 'fast' decreasing trend in immediate recruitment observed since 1998 might have been accentuated by, or simply be an artefact of, earlier survey starting dates.

In southern ENS, the year 1998 also stands, but for its lack of commercial-sized soft shell crab found during the survey in relation with the quantity of the smaller-sized category observed during the survey of 1997. In this case, most of the stations (96 out of 162) were sampled after Sept. 25 and covered all of CFA 24 and part of CFA 23. There is the possibility that crab that should have been labelled as carapace condition 2 (or white) was classified as 3.

Snow crab distribution - In northern ENS, data on commercial-sized adult soft-shell males that was collected during the spring survey and the related total biomass, should not be used as is since it may be grossly misrepresenting the true snow crab population and distribution in that area. On the other hand, the commercial-sized adult hard shell males do not seem to be affected by the 'near shore factor", and are considered to be representative of this category of crab. During the spring survey in northern ENS, the highest density and concentration of hard shell crab was observed in 1999, while the highest biomass of hard shell crab were reported in 2000 and 2001. The density distribution map of September clearly shows a high density patch of adult soft shell crab in CFA 21 and 22 northern, on the near shore side of the trough, while hard-crab are mainly found outside that concentration, along the line separating CFAs 21 and 22 northern (Fig. 19).

In southern ENS, and except for 1997, the majority of commercial-sized adult hard shell males seem to be found in sub-areas A and B of CFAs 23 and 24. In 1997, adult hard shell males were mostly found in 24B/D, but the survey coverage in CFA 23 was limited that year.

In both northern and southern ENS, mature females and pre-recruits trends have been decreasing since 1997-98, while that of commercial-sized adult males has remained constant over the same period. The decrease in recruitment and mature females is to be expected in any normal snow crab stock and has been observed in other regions such as the southern Gulf. and western Cape Breton. However, difference was observed in the magnitude of the decrease which is more marked in ENS than what was observed in southern Gulf and western Cape Breton.

Snow crab movement – Seasonal movement between shallow and deeper areas may occur between the time of the trawl survey and the beginning of the subsequent fishing season. This may be particularly true in the case of molting crab (Sainte-Marie and Hazel 1992; Lovrich et al. 1995). Movement is more apparent between smaller areas (Hébert et al. 2000). Movement of crab among CFAs 20, 21 and 22, and among CFAs 23 and 24, is assumed but not explicitly taken into account in the assessment. Recent tagging experiments have shown that crab released in CFA 22 Glace Bay Hole could be recaptured as far away as CFA 18 and 19 in western Cape Breton (Fig. 35). Tagged crab released in CFA 24A could be recaptured far eastward into CFA 23 or westward into CFA 24E (Fig. 35). Examples of long distance movement are also found in SGSL, with recapture from the Gulf Region found in northern ENS (Fig. 36). It is, however, still too early to try to quantify the extent of the movement in ENS. Existing literature seems to indicate that the majority of tagged crabs were recaptured within 15 km of their original tagging sites (Watson 1970; Watson and Wells 1972; Elner 1982; Coulombe et al. 1985; Hooper 1986; Brêthes et Coulombe 1989; Lefêbre et Brêthes 1991). Recaptured crabs from northern ENS seem to have been more active than those from sites in the Gulf in the distance traveled (Fig. 37). It may be possible that some areas such as the northern side of the trough in CFA 19 or the continuous trough shared by CFAs 20, 21 and 22 (John Tremblay, unpubl. Data) constitute a stable environment (Figs. 35, 36 and 37). Other areas such as the tip of Cape St. Lawrence or CFA 22 outer are the most active areas. Another source of uncertainty is the change in geographic distribution patterns of commercial adult crab that seem to spread over a larger surface and into peripheral areas, and vice-versa (Hébert et al. 2000).

Mortality and biomass estimation

Since 1997, the snow crab trawl survey in ENS generally occurs in late spring / early summer (May, June, early July) with the goal of having all the stations completed prior to the opening of the fisheries in CFAs 20 to 24. These fisheries are historically summer fisheries (July to November), although in recent years, parts (2001) or all (2000) of the southern ENS fishery have started earlier (June). Entry of the trawl survey data at DFO Science Branch occurs during the summer, the data analysis during the fall, and the final results are presented at the RAP meeting, and then at Management meetings, during the winter (following year). Overall, 14 months will pass between the trawl survey in a given year and the start of the fisheries the following year and for which the prediction of biomass estimates are used as an important fishery management tool.

This implies that crabs observed during a given survey must survive the snow crab fisheries immediately following the survey, plus other fishing activities occurring throughout the year. Fourteen months is a long period of time and one must also assume 'natural' mortality (i.e. any source of mortality not related to human activities) such as predation, disease and age-related death. The mortality issue in previous research documents was dealt with only by withdrawing the known mortality any given year (i.e. landings) from the biomass estimated from the survey done earlier the same year. At the time, the work of the Snow Crab Section, DFO-Science, was mainly focused on adapting the trawl survey developed in the SGSL to the different particularities found in ENS (Biron et al., 2001). More confident in the snow crab trawl survey methodology being developed in ENS, as well as more conscious of its limitations, the sources of mortality other than landings will now be considered in the assessment and quantified whenever possible.

Soft and white crab mortality - Mortality rates of 16% for soft crab and 5% for white crab proposed in this document are based on the experiment realised in August 2001 in southern ENS, and are obtained by combining the number of crabs of both health categories 'weak' and 'dead'. Although technically alive (but not responding to stimulation), crabs in the health category 'weak' were so weak that it is safe to assume they would have died if kept under 'observation' for a longer period than 72 hrs. It has been found that although mortality of discarded spanner crab *Ranina ranina* was noted during the first few days, it could take as long as 10 days for crabs missing two legs, to 50 days for the ones missing only mouth appendices to die (Kennelly et al. 1990).

The vulnerability of soft-shelled - and white snow crab to trapping and to the manipulation on board of fishing vessels has been revealed by Miller (1977) and by Dufour et al. (1997). In general, softer (shell hardness < 60 durometer units) and bigger (> 95 mm CW) crabs are the most vulnerable to manipulation. The loss of legs and/or vitality is evenly crucial as the mortality rates increase among crabs missing more than 1 leg, and for weak crabs (Dufour et al. 1997). Miller (1977) reported mortality rates between 20 to 64% for soft and white snow crabs exposed to air and sunlight on the vessel deck for 3 to 35 minutes in the summer. Dufour et al. (1997) found mortality rates of 14.3% for soft crab (< 60 durometer units) and 2.2% for hard-crab (>80 durometer units) following 'normal' fishing activities. However these rates could reach up to 50% in the case of weak crab with more than 2 missing legs compared to 10.5% for similar crabs with no missing legs.

In that respect, the experiment conducted in August 2001 was completed under 'ideal' survival conditions for the crab; the sky was overcast, the air was cool, and crabs were handled with the greatest care. Crabs were handpicked directly from the trap in an effort to reduce stress and injuries, protected from desiccation while onboard and returned quickly to the water. In other words, this represents one of the best scenarios of handling soft and white crabs in the summer time rather than the worse. Therefore, the mortality rates found for soft (16%) and white (5%) crab should be considered as minimum mortality rates resulting from normal snow crab fishery's practices in ENS. In order to confirm these findings, a similar experiment should be repeated in 2002.

The minimum mortality caused by the fishery in 2001 can be largely estimated based on the seasonal percentage of soft and white shell adult crab ≥95 mm CW observed by the at-sea sampling in relation with the total reported landings from the submitted logbooks. The mortality of soft and white shell crab was estimated at 79 t in northern ENS and 179 t in southern ENS.

Natural mortality

Although very difficult to quantify natural mortality, the quantity of category-5 crabs found during the trawl survey are normally subtracted from the predicted (forecasted) total biomass in the southern Gulf (Hébert et al. 2000). Most of these very old carapace crabs are not expected to be available for the fishery that follows the trawl survey 6-7 months later. The same should be applied to the ENS fisheries. In 2001, the amount of old category-5 crabs were estimated at 62 ± 0.1 t in northern ENS and 208 ± 84 t in southern ENS.

It should be noted that the categorisation of carapace condition into five groups, based on the scale and criteria developed for the SGSL, was not directly applicable in ENS (Biron et al. 2000). Therefore, it is possible that the very old carapace crab category is over- or underestimated. Currently work is being done to develop a scale and criteria specific to ENS in the future. Identification of the snow crab epibionts in ENS, as well as differences in epibiont communities in relation with depth, season, and geographic location, is being carried out in co-operation with the University of Moncton. Determination of the proper age of a few selected crabs that were categorised with the existing scale and criteria is being done under the supervision of J. Smith (DFO Science, BIO). In this latter case, the age will be determined by using the Th-228/Ra-228 ratio as a measure of the time elapsed between the previous molt and the time of the analytical measurement.

Biomass estimates and predicted biomass estimates

Biomass estimates for 2001 – In northern ENS, recruitment biomass (soft-crab) and the related total biomass estimated from the spring survey since 1997 are suspicious. The commercial biomass estimates (hard-crab) may be representative and a good index, and results from the ongoing seasonal survey should help clarify this. In the mean time, there is no doubt that results from the fall survey in 2001 are more representative of the snow crab population in northern ENS.

Changing the timing of the survey in northern ENS (by using September results) and eliminating sources of underestimation and better accounting of the mortality in southern ENS has resulted in relative abundance indexes (i.e. total biomass) that were better

representatives of the snow crab population in ENS. These indexes were also less conservative than in previous years.

Predicted biomass estimates for 2002 - The September 2001 survey in northern ENS indicated that there were 3,982 t of total estimated biomass. Assuming that most of the snow crab habitat in northern ENS has been covered by the trawl survey in Sept. 2001 and that no other losses than old category-5 crab will occur in the mean time, the biomass available for the 2002 fishery should be 3,920 t (3,982 t –62 t of category-5).

In southern ENS, the 2001 survey indicated that there was 33,139 t of total biomass of adult male ≥95 mm. The fishery in CFAs 23 and CFA 24 harvested 8,456 t (trap survey and commercial landings from slope not included), plus the soft and white crab mortality from the fishery estimated at 189 t, and the amount of old crab with carapace condition 5 estimated at 208 t. Assuming that all major fishing grounds in southern ENS have been covered by the trawl survey in 2001 and that no other losses will occur in the mean time, the biomass available for the 2002 fishery should be 24,286 t.

Soft and white crab protection

The decision to triple the TAC in southern ENS in 2000 was based, in part, on the introduction of the trawl survey, which indicated a higher biomass and wider distribution of snow crab than previously believed. In some areas, this population was left unexploited for some time and, therefore, had been accumulating crabs that had been progressively getting older (Biron et al. 2000). This was corroborated by other sources of information such as at-sea observer data, fishery data (logbooks), and other fishermen observations. One of the management strategies adopted in 2000 was to greatly increase the TAC to capture this ageing crab before it was lost to natural mortality. Overall, soft and white crabs, although observed by some fishermen, were not considered problematic in 2000. The same strategy was applied in 2001, but this time, better at-sea observer coverage and fishermen's observations indicated an increase in the amount of soft and white crab being captured in some areas, especially towards the end of the summer. In one of the trips covered by an at-sea observer, the average percentage of soft shell crab captured reached as high as 60%, but this was an exception and not the norm being observed.

There are ways to reduce the amount of soft and white crabs being captured and to reduce handling mortality of those that are captured in a snow crab fishery:

-An earlier fishing season: by starting earlier, crabs are believed to be still too soft to enter the traps. Indications of notable increases in soft shell crabs in all sub-areas did not start until mid-July, while levels higher than 20% did not appear until mid-August, in most cases. This is also true for 23D + 24D, even if they started 5 weeks earlier than the other sub areas.

-A shorter fishing season: overall, the first 10 weeks of the fishing season did not appear to be problematic in terms of percentages of soft and white crab being captured in 2001. Again, the longer a fishing season runs, combined with less hard-crab remaining on the bottom and the fact that soft and white crabs are getting harder as the season progresses, then greater is the risk of capturing more soft and white crab.

-Good husbandry practices: this includes careful handling of the crab once on board a vessel and quick return to the water to moving out of an area if the soft crab is higher than a certain predetermined level. In general, softer and bigger (>95 mm CW) crabs are the most vulnerable to manipulations (Miller 1977, Dufour et al. 1997). The loss of legs and/or vitality is evenly crucial as the mortality rate increases among crabs missing more than 1 leg and for weak crabs (Dufour et al. 1997).

-Redistribution / reduction of fishing effort: in some instances, a seasonal high level of soft shell crab in a given area may simply indicate a high level of fishing effort in that area, and vice-versa. If it is too high, the effort could/should be redistributed outside of the problematic area, or at the very least, reduced within the problematic area, before the next fishing season. It can also indicate the potential for more effort if it remains very low all season.

-Closure of grids/sub-areas/fisheries: In other areas such as in the SGSL, soft and white crab protocol were developed to minimise mortality of these crabs by closing concerned areas under certain conditions. This option will require preparation, at-sea sampling and/or enforcement.

CONCLUSION / RECOMMENDATIONS

By using September biomass estimation results in northern ENS, or by eliminating sources of underestimation and better accounting of the mortality in southern ENS, the relative abundance indexes were thought to be better representative of the snow crab population, but were also less conservative than in previous years. Although these improvements have produced better relative abundance indexes based on the snow crab trawl survey, it did not account for differences in capturability among the different categories of snow crab in the trawl, or for natural mortality. These relative indexes should not be taken as absolute numbers.

In northern ENS, a new index is being established based on a trawl survey conducted in September instead of May. There is nothing to compare September 2001 with for now. Based on the spring survey before the fishery, the survey size frequency of male indicates future recruitment was still on the decreasing trend observed since 1997, while the commercial-sized hard shell males have remained similar to 2000. The decreasing trend in immediate recruitment might have been accentuated by earlier survey starting dates. Trends in CPUE in CFAs 20-22, during the same period, did not suggest any stock decline.

In southern ENS, biomass estimates of commercial-sized male crabs observed before the fishery in 2001 were similar to that of 2000. The survey size frequency of male indicated future recruitment was still on the decreasing trend that has been observed since the trawl survey commenced in 1997. Trends in CPUE in most sub-areas of CFAs 23 and 24, since 2000, did not suggest any stock decline.

'Traffic light' style analysis – The traffic light analysis has been adopted by the Northwest Atlantic Fisheries Organisation (NAFO) as a precautionary approach to assessment and management of stock, and it is becoming normal to see some form of 'traffic light analysis' as a conclusion of a stock assessment. Some chosen parameters that are indicative of the

stock status are compared with the previous year, and a green, yellow or red 'light' is determined for the current year. The challenge is to find valid parameters that are indicatives of the current health of the snow crab stock in ENS. As in 2000, an attempt at traffic light analysis is presented in Appendix 5 for discussion purpose. Historical fishery data tables of CFAs 20, 21 and 22 in northern and CFAs 23 and 24 in southern ENS have been have been combined for this exercise (Appendix 5).

Management considerations and recommendations

Fishing season in southern ENS

Since 2000, snow crab fishing in southern ENS has occurred between June 1st and late November/early December. In 2001, 80% of the landings occurred in June-August and had reached 90% by Sept. 15. In 2000, when all sub-areas had started fishing on June 1st, 90% of the landings occurred in June-August and over 95% by Sept. 15. In general, landings after Sept. 15 are due to personal choices, to vessels fishing multiple licenses, delays in attributing part of the overall TAC to specific individuals, or following mechanical or health problems, but not due to a lack of commercial crab.

Since 2000, the length of the fishing season in southern ENS is not reasonable from a biological point of view. Allowing it to run too late it increases the likelihood of white crab problems / mortality as described above. The length of the season is also becoming unacceptable from an analytical / data management point of view by seriously limiting the time to properly analyses all the biological and fishery data in time for the RAP and Management meetings. Again this year, December 15, 2001 was chosen as the closing date for receiving electronic logbook file updates, at-sea observer data, and for hard copies of the original logbooks. The last of the slope trap survey data came in during the first week of January 2002. All of the data has to go through data entry and verification processes before analysis.

It is therefore highly recommended that the fishing season be shortened to 10-15 weeks in southern ENS. In theory, if the fishing season remains as in 2001 (i.e. a June 1st start for sub-areas D, and July for the remaining sub-areas), there should be enough time to do a trawl survey before the fishery. But if moving the trawl survey after the fishery is to be considered then the fishing season should end before August 31st.

Soft and White crab protection

There should be a "soft and white crab protocol" developed comparable to that applied to the SGSL in order to minimise the mortality of these crabs and to protect future recruitment to the fishery. This is especially true if the current fishing effort is to be maintained. Furthermore, it should be clear to all that, at the present time, DFO-Science does not have the proper tools or guidelines to react if the capture of soft or white crab was to become problematic in ENS in the future. But first, "problematic" for ENS needs to be defined. In Area 12, a sophisticated protocol has been developed on a grid by grid basis to solely protect soft shell crab (hardness < 68 durometer reading) by closing concerned grids if the rate exceed 20% under certain conditions (Hebert et al. 2000). That works for Area 12 because it is a spring fishery and is usually conducted before the white crabs enter the fishery. In Area 19 (summer fishery), they have chosen the route of increasing the claw hardness limit for

legal release at 72 durometer units to protect white crab from being landed. By experience, the more sophisticated the protocol, the more time, at-sea sampling and/or enforcement will be required to make it work.

Research considerations and recommendations

Trawl survey timing in northern ENS

It is recommended that the "annual" trawl survey in northern ENS be conducted in September rather than in May. Although the decision may be considered premature because the seasonal effect experiment is still ongoing, it is obvious that the survey in May had missed the recruitment altogether, which is an important factor in estimating next year's exploitable biomass. A survey in July, just before the start of the fishery would probably be the most representative of the snow crab population prior to opening date, but biomass estimates for the following year would still be based on 12 month 'old' data and prior to a fishery (i.e. having to deal with fishery mortality and landings). In that respect and in the context of the experiment, the July sampling is more for the establishment of a reference point (summer, prior to fishery) than for the consideration of it being a valid timing for the trawl survey. January survey results may turn out to be the best time for the survey. In such a case however, results would not be ready on time for the winter RAP and Management meetings. Bottom water temperatures are believed to be generally within similar ranges and distribution patterns in July and September, while cold water is much more prevalent in early May with cold bottom temperatures extending all the way up to the shore line (Davis and Brown 1997).

September is therefore the logical choice: it is 9 months prior to the next fishery (rather than 14, if kept in May), after that year's fishery, and seemingly more representative of all snow crab categories. A survey later than September always run into the risk of bad weather that may lead to the cancellation of the survey, which was the case in southern ENS in November 1998. A survey earlier than September 15 falls into the official fishing season (July 22nd to Sept. 15), and although the fishery has been completed relatively quickly in the last 3 years, there are past examples of people having to fish the entire season and still not catching their quota.

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Table 1. Summary of the Management Plan measures for 2001.[1]

Area	Season	Regular licenses	Traps allowed	Quota per regular licenses (kg)		Temporary permits	Traps allowed	Total quota temporary permits (kg)
				per license	total			
20	July 22- Sept. 15	5	30	13,600	68,000	6	30	50,000
21	July 22- Sept. 15	32	25	11,344	363,000	none	none	none
22	Northern group:[2]							
	July 22- Sept. 15	20	30	15,900	318,000	none	none	none
	Southern group:[2]							
	July 22- Sept. 15	17	30	15,706	267,000	none	none	none
23	*Sub-area 23D*							
	June 1st – Oct. 31	24	45	74,004	1,776,100	59	45	2,984,900
	All other sub-areas							
	July 1st – Oct. 31							
	Exploratory slope							
	July 1st – Nov. 30			50,000		2	45	100,000
24	*Sub-area 24D*							
	June 1st – Oct. 31	23	40	72,009	1,656,200	57	40	2,405,800
	Exploratory slope							
	July 1st – Nov. 30							
	All other sub-areas							
	July 1st – Oct. 31			50,000		2	40	100,000

[1] Information from Integrated fishery management plan (Anonymous, 1999)
[2] Both groups have agreed not to fish on Sundays.

Table 2. Landings, catch rate and effort statistics for Snow Crab (*Chionoecetes opilio)* for eastern Nova Scotia (Crab Fishing Areas 20 to 24), 1978 - 2001.

Year	Active licenses/permits	TAC (t)	Landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1978	42	-	801	28.4	28.2
1979	98	-	1,634	28.7	56.9
1980	99	-	819	19.8	41.4
1981	55	-	156	21.8	7.2
1982	67	-	554	16.7	33.2
1983	97	-	259	9.6	27.0
1984	51	-	124	8.6	14.4
1985	29	-	89	8.7	10.2
1986	29	-	120	10.2	11.8
1987	61	-	361	12.6	28.7
1988	88	-	596	14.6	40.8
1989	100	-	616	18.7	32.9
1990	102	-	1,152	25.4	45.4
1991	101	-	1,533	30.9	49.6
1992	104	-	1,797	32.5	55.3
1993	113	-	2,016	28.1	71.7
1994	117	-	1,551	21.2	73.2
1995	134	-	1,554	22.0	70.6
1996	124	1,701	1,491	29.6	50.3
1997	133	1,703	1,691	37.3	44.9
1998	141	2,331	2,238	58.0	38.6
1999	160	3,600	3,599	66.5	54.1
2000	235	9,814	9,718	76.4	127.2
2001	243	9,848	9,917	86.7	114.4
Average (all)		-	1,849	29.7	47.0
Average (97-01)		5,459	5,433	65.0	75.8

Table 3. Landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 20, 1978 - 2001.

Year	Active boats	TAC (t)	Landing statistics (t)	Mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1978	-	-	61	-	-
1979	8	-	80	8.2	9.8
1980	8	-	34	8.3	4.1
1981	6	-	2	-	-
1982	-	-	2	-	-
1983	12	-	23	1.7	13.5
1984	2	-	10	-	-
1985	1	-	1	-	-
1986	2	-	0	1.9	-
1987	3	-	1	-	-
1988	4	-	17	7.9	2.2
1989	5	-	8	-	-
1990	4	-	5	5.3	0.9
1991	4	-	14	16.3	0.9
1992	3	-	18	40.6	0.4
1993	4	-	20	17.3	1.2
1994	5	-	29	20.2	1.4
1995	5	-	44	19.8	2.2
1996	5	45	43	14.7	2.9
1997	5	45	45	20.2	2.3
1998	5	45	45	35.5	1.3
1999	9	91	90	32.3	2.8
2000	10	118	118	46.7	2.5
2001	11	118	117	64.8	1.8
average (all)		-	34.4	21.2	3.1
average (97-01)		83.4	83.0	39.9	2.1

Table 4. Weekly landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 20, in 2001.

a) Weekly landings statistics

week	landings (kg)		
	all	permanent	temporary
July 22	36,913	28,609	8,304
July 29	62,094	37,114	24,980
Aug. 05	9,817	2,440	7,377
Aug. 12	7,733	-	7,733
total[2]	116,557	68,163	48,394

b) Weekly catch rate statistics

week	CPUE (kg/trap haul)		
	all	permanent	temporary
July 22	82.6	107.6	45.1
July 29	61.4	83.9	44.0
Aug. 05	48.3	72.0	45.3
Aug. 12	54.0	-	54.0
total[2]	64.8	92.9	45.7

c) Weekly effort statistics

week	Effort (total number of trap hauls)		
	all	permanent	temporary
July 22	447	226	184
July 29	1,012	442	567
Aug. 05	203	34	163
Aug. 12	143	-	143
total[2]	1,797	739	1,059

[2] Total seasonal landings.

Table 5. Seasonal catch composition, in percentage, from at-sea samples for north-eastern Nova Scotia in 2001.

a) Catch composition in Area 20 (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
4	16	< 95 mm	1.7	15.2	0.2	0.0	2.0	15.2	17.2
		> 95 mm	2.5	79.4	0.5	0.5	2.9	79.9	82.8
		total	4.2	94.6	0.7	0.5	4.9	95.1	100.0

b) Catch composition in Area 21 (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	Adult	adolescent	adult	adolescent	adult	
7	13	< 95 mm	13.3	4.0	1.7	0.0	15.0	4.0	19.1
		> 95 mm	41.0	31.6	6.2	2.1	47.2	33.7	80.9
		total	54.3	35.6	7.9	2.1	62.2	37.8	100.0

c) Catch composition in Area 22 (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
8	40	< 95 mm	0.7	19.8	0.1	0.2	0.8	20.0	20.8
		> 95 mm	1.7	71.9	0.7	4.9	2.4	76.8	79.2
		total	2.4	91.8	0.7	5.1	3.1	96.9	100.0

Table 6. Landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 21, 1978-2001.

Year	Active licenses	TAC (t)	Landing statistics (t)	Mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1978	16	-	247	11.3	21.9
1979	27	-	243	10.7	22.7
1980	31	-	153	9.7	15.8
1981	22	-	34	13.6	2.5
1982	20	-	94	7.9	11.9
1983	27	-	48	5.1	9.4
1984	19	-	18	2.9	6.2
1985	10	-	10	3.5	2.9
1986	12	-	7	2.5	2.8
1987	21	-	56	6.4	8.8
1988	24	-	125	9.6	13.0
1989	30	-	154	13.7	11.2
1990	31	-	167	13.1	12.7
1991	29	-	157	14.9	10.5
1992	31	-	196	16.7	11.7
1993	30	-	168	14.2	11.8
1994	31	-	107	7.2	14.9
1995	32	-	100	8.3	12.0
1996	32	145	136	9.7	13.9
1997	32	145	146	35.7	4.1
1998	32	218	216	53.0	4.1
1999	32	290	291	62.1	4.7
2000	32	363	364	62.1	5.9
2001	32	363	363	93.4	3.9
average (all)		-	150.0	20.3	10.0
average (97-01)		275.8	276.0	61.3	4.5

Table 7. Weekly landings, catch rate and effort statistics for Snow Crab, Crab Fishing Area 21, 2001.

week	landings (kg)	CPUE (kg/trap haul)	Effort (total number of trap hauls)
July 22	233,581	100.5	2,324
July 29	120,663	84.6	1,427
Aug. 05	6,135	69.2	89
Aug. 12	2,728	55.0	51
total[1]	363,161	93.4	3,888

[1] Total seasonal landings and seasonal CPUE were used to obtain these results.

Table 8. Landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 22, 1978 - 2001.

Year	Active licenses	TAC (t)	Landing statistics (t)	Mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1978	15	-	341	28.9	11.8
1979	35	-	684	38.4	17.8
1980	26	-	227	21.0	10.8
1981	11	-	50	12.5	4.0
1982	21	-	153	19.6	7.8
1983	26	-	52	8.5	6.1
1984	7	-	18	8.6	2.1
1985	8	-	3	6.0	0.5
1986	5	-	18	10.0	1.8
1987	16	-	63	10.5	6.0
1988	29	-	114	10.4	11.0
1989	26	-	93	15.0	6.2
1990	26	-	119	9.0	13.2
1991	24	-	183	18.5	9.9
1992	27	-	240	24.2	9.9
1993	40	-	390	21.0	18.6
1994	38	-	259	12.0	21.6
1995	37	-	284	9.7	29.3
1996	37	350	189	10.3	18.3
1997	37	350	343	20.8	16.5
1998	37	397	396	38.2	10.4
1999	37	519	518	58.5	8.9
2000	37	534	535	82.3	6.5
2001	37	585	586	105.1	5.6
average (all)		-	244.1	25.0	10.6
average (97-01)		476.8	475.6	61.0	9.6

Table 9. Weekly landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 22, in 2001.

a) Weekly landings statistics

week	Landings (kg)		
	all	northern	outer area
July 22	413,844	205,598	208,246
July 29	167,073	108,761	58,312
Aug. 05	5,423	4,248	1,175
total[1]	586,340	318,607	267,733

b) Weekly catch rate statistics

week	CPUE (kg/trap haul)		
	all	northern	outer area
July 22	117.5	96.2	147.6
July 29	83.7	76.5	103.2
Aug. 05	68.0	68.0	-
total[1]	105.1	87.9	135.9

c) Weekly effort statistics

week	Effort (total number of trap hauls)		
	all	northern	outer area
July 22	3,522	2,137	1,411
July 29	1,996	1,422	565
Aug. 05	80	62	-
total[1]	5,577	3,625	1,976

[1] Total seasonal landings.

Table 10. Landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 23, 1978 - 2001.

Year	Active licenses/permits	TAC (t)	Landing statistics (t)	Mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1978	-	-	347	51.5	6.7
1979	-	-	608	43.4	14.0
1980	-	-	343	39.0	8.8
1981	-	-	82	26.5	3.1
1982	-	-	253	28.8	8.8
1983	-	-	119	16.5	7.2
1984	-	-	41	18.6	2.2
1985	5	-	28	14.7	1.9
1986	6	-	49	14.4	3.4
1987	14	-	157	26.2	6.0
1988	21	-	207	24.9	8.3
1989	25	-	243	28.3	8.6
1990	27	-	386	36.4	10.6
1991	23	-	528	44.8	11.8
1992	22	-	595	49.6	12.0
1993	26	-	770	53.1	14.5
1994	22	-	497	33.4	14.9
1995	31	-	576	51.8	11.1
1996	27	592	564	65.6	8.6
1997	30	593	592	57.8	10.2
1998	34	848	813	77.0	10.6
1999		1,300	1,300	87.3	14.9
2000	79	4,425	4,401	85.0	51.8
2001	85	4,789	4,805	82.6	59.0
average (all)		-	763	44.1	12.9
average (97-01)		2,391	2,382	63.1	29.3

Table 11. Weekly landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 23, in 2001.

week	Landings (kg)					CPUE (kg/trap haul)					Effort (total number of trap hauls)				
	all	permanent	temporary			all	permanent	temporary			all	permanent	temporary		
			b	c	d			b	c	d			b	c	d
June 03	123,913	-	-	-	123,913	50.4	-	-	-	50.4	2,459	-	-	-	2,459
June 10	92,525	-	-	-	92,525	46.5	-	-	-	46.5	1,989	-	-	-	1,989
June 17	115,864	-	-	-	115,864	47.1	-	-	-	47.1	2,460	-	-	-	2,460
June 24	65,815	-	-	-	65,815	54.5	-	-	-	54.5	1,207	-	-	-	1,207
July 01	176,793	72,871	44,504	-	59,418	90.3	117.9	141.7	-	57.9	1,958	618	314	-	1,026
July 08	462,046	228,290	120,666	28,544	88,029	100.7	119.4	120.4	172.0	57.5	4,587	1,912	1,002	166	1,531
July 15	558,950	297,211	173,928	20,677	72,083	107.0	130.2	123.4	164.1	48.3	5,226	2,283	1,410	126	1,493
July 22	456,773	211,600	148,623	26,872	67,872	96.6	121.9	107.2	200.5	47.7	4,728	1,735	1,387	134	1,422
July 29	382,515	156,454	165,300	34,158	26,603	105.3	128.7	102.5	177.0	43.1	3,634	1,216	1,613	193	617
Aug. 05	212,929	83,846	97,648	1,556	29,879	102.3	137.9	112.9	129.7	51.1	2,082	608	865	12	585
Aug. 12	594,464	223,435	276,522	31,807	62,697	91.0	112.6	97.0	140.2	44.4	6,535	1,984	2,851	227	1,411
Aug. 19	360,251	164,897	120,017	15,839	59,498	81.5	98.4	87.6	132.0	48.4	4,419	1,676	1,370	120	1,229
Aug. 26	214,371	78,650	78,913	196	56,612	75.9	97.6	90.6	-	50.8	2,825	806	871	-	1,115
Sept. 02	141,804	62,338	38,922	2,303	38,241	75.8	101.9	96.3	92.1	49.7	1,872	612	404	25	769
Sept. 09	204,177	61,693	72,920	16,293	55,381	76.3	86.6	87.1	129.3	53.8	2,675	713	838	126	1,029
Sept. 16	206,192	46,539	93,215	8,810	57,342	66.0	84.2	79.5	106.5	44.4	3,125	553	1,172	83	1,292
Sept. 23	136,699	30,335	40,687	4,809	57,878	72.1	97.6	69.2	85.9	71.2	1,797	311	631	56	813
Sept. 30	94,172	13,306	37,585	4,015	39,226	65.1	81.6	71.1	97.9	55.1	1,448	163	529	41	713
Oct. 07	110,814	20,145	52,010	10,740	31,431	75.3	91.6	76.0	116.7	59.1	1,472	220	684	92	532
Oct. 14	24,045	-	19,247	-	4,798	92.5	-	101.3	-	68.5	260	-	190	-	70
Oct. 21	83,416	15,665	45,848	4,234	17,669	76.7	65.8	87.8	57.1	71.0	1,088	238	522	174	249
Oct. 28	29,116	2,731	25,473	-	912	62.8	68.3	67.7	-	19.4	464	40	376	-	47
Nov. 04	8,108	-	8,110	-	-	53.3	-	53.4	-	-	152	-	152	-	-
Nov. 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nov. 18	12,027	-	-	-	12,027	72.9	-	-	-	72.9	165	-	-	-	165
Nov. 25	1,256	-	-	-	1,256	38.1	-	-	-	38.1	33	-	-	-	33
Dec. 02	2,759	-	-	-	2,759	32.8	-	-	-	32.8	84	-	-	-	84
total	4,804,911[2]	1,778,246[2]	1,663,138	210,853	1,231,022	82.6	112.6	97.0	143.7	50.9	58,959	15,719	17,141	1,467	24,177

[2] Total landings from statistic, DFO.

Table 12. Weekly landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 23, sub-area D, in 2001.

CFA 23 sub-area 23D												
week	Landings (kg)				CPUE (kg/trap haul)				Effort (total number of trap hauls)			
	all	artimon	gully	slope	all	artimon	gully	slope	all	artimon	gully	slope
June 03	123,913	38,050	77,969	7,894	50.4	42.2	54.8	58.9	2,459	902	1,423	134
June 10	92,525	36,865	46,768	8,892	46.5	41.7	48.3	65.9	1,989	885	969	135
June 17	115,864	43,586	48,741	23,537	47.1	38.1	44.1	111.0	2,460	1,144	1,104	212
June 24	65,815	26,448	30,633	8,734	54.5	55.3	54.1	53.6	1,207	478	566	163
July 01	59,418	31,636	17,319	10,463	57.9	59.1	77.7	39.0	1,026	535	223	268
July 08	88,029	39,020	35,646	8,188	57.5	50.5	66.1	71.2	1,531	773	540	115
July 15	72,083	23,801	31,652	7,830	48.3	40.3	61.0	44.2	1,493	591	519	177
July 22	67,872	24,923	22,595	25,376	47.7	27.1	61.1	72.1	1,422	921	370	352
July 29	26,603	11,495	10,850	4,258	43.1	32.9	58.6	51.3	617	349	185	83
Aug. 05	29,879	4,023	13,690	12,166	51.1	52.9	53.1	48.5	585	76	258	251
Aug. 12	62,697	15,865	36,067	10,765	44.4	35.8	44.4	69.0	1,411	443	812	156
Aug. 19	59,498	19,343	23,413	16,742	48.4	52.1	37.7	70.6	1,229	371	621	237
Aug. 26	56,612	13,492	16,823	26,297	50.8	50.3	39.7	62.2	1,115	268	424	423
Sept. 02	38,241	10,419	6,817	21,005	49.7	47.6	32.8	61.4	769	219	208	342
Sept. 09	55,381	15,009	10,526	27,736	53.8	54.9	54.8	52.9	1,029	274	192	524
Sept. 16	57,342	15,565	13,564	28,213	44.4	49.3	43.9	42.6	1,292	316	309	663
Sept. 23	57,878	15,523	7,317	38,942	71.2	75.0	64.8	75.3	813	207	113	517
Sept. 30	39,226	2,598	-	39,266	55.1	41.2	-	55.1	776	63	-	713
Oct. 07	31,431	9,961	1,497	29,933	59.1	67.3	62.4	58.9	532	148	24	508
Oct. 14	4,798	-	-	4,798	68.5	-	-	68.5	70	-	-	70
Oct. 21	17,669	-	3,577	14,092	71.0	-	40.6	87.5	249	-	88	161
Oct. 28	912	-	-	912	19.4	-	-	19.4	47	-	-	47
Nov. 04	-	-	-	-	-	-	-	-	-	-	-	-
Nov. 11	-	-	-	-	-	-	-	-	-	-	-	-
Nov. 18	12,027	-	-	12,027	72.9	-	-	72.9	165	-	-	165
Nov. 25	1,256	-	-	1,256	38.1	-	-	38.1	33	-	-	33
Dec. 02	2,759	-	-	2,759	32.8	-	-	32.8	84	-	-	84
total	1,231,022	397,622	455,464	392,081	50.9	44.9	50.8	59.9	24,177	8,863	8,957	6,543

Table 13. Seasonal catch composition, in percentage, from at-sea samples for Crab Fishing Area 23 in 2001.

a) Catch composition in CFA 23, all sub-areas (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
78	638	< 95 mm	2.2	8.1	0.4	0.3	2.6	8.4	11.0
		> 95 mm	10.8	69.0	2.2	7.0	13.0	76.0	89.0
		total	13.0	77.1	2.7	7.3	15.6	84.4	100.0

b) Catch composition in CFA 23, sub-area A (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
27	167	< 95 mm	3.2	11.8	0.4	0.3	3.6	12.1	15.7
		> 95 mm	7.9	65.8	2.1	8.4	10.0	74.3	84.3
		total	11.1	77.7	2.5	8.7	13.6	86.4	100.0

c) Catch composition in CFA 23, sub-area B (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
22	147	< 95 mm	3.0	7.3	0.5	0.3	3.6	7.6	11.2
		> 95 mm	11.1	63.3	2.6	11.8	13.7	75.2	88.8
		total	14.1	70.7	3.1	12.1	17.2	82.8	100.0

d) Catch composition in CFA 23, sub-area C (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
2	16	< 95 mm	1.6	16.4	0.5	0.0	2.1	16.4	18.5
		> 95 mm	3.2	76.5	1.1	0.6	4.4	77.1	81.5
		total	4.9	92.9	1.6	0.6	6.5	93.5	100.0

e) Catch composition in CFA 23, sub-area D (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
27	283	< 95 mm	1.2	5.8	0.3	0.2	1.5	6.1	7.6
		> 95 mm	12.8	73.6	2.2	3.9	15.0	77.5	92.4
		total	13.9	79.4	2.5	4.1	16.5	83.5	100.0

Table 14a. Seasonal and weekly soft-shell percentages for Crab Fishing Area 23, from at-sea samples in 2001.

	CFA 23				
Week	all	a	b	c	d
June 03	0.0	-	-	-	0.0
June 10	0.3	-	-	-	0.3
June 17	3.2	-	-	-	3.2
June 24	3.3	-	-	-	3.3
July 01	0.4	-	-	-	0.4
July 08	6.4	2.1	3.8	-	16.2
July 15	6.0	4.9	6.2	-	14.1
July 22	11.7	-	7.6	-	33.5
July 29	12.2	15.0	4.6	-	13.6
Aug. 05	18.4	14.5	23.4	-	-
Aug. 12	18.3	21.5	19.6	-	13.9
Aug. 19	24.5	24.5	-	-	-
Aug. 26	24.3	20.1	30.9	-	-
Sept. 02	28.4	26.1	29.6	-	-
Sept. 09	18.6	18.6	-	-	-
Sept. 16	60.2	-	60.2	-	-
Sept. 23	28.3	-	28.3	-	-
Sept. 30	-	-	-	-	-
Oct. 07	-	-	-	-	-
Oct. 14	10.4	-	10.4	-	-
Total	13.2	14.3	20.7	2.1	4.9

Table 14b. Seasonal and weekly soft-shell (in number) for Crab Fishing Area 23, from at-sea samples in 2001 [number of trips (number of traps)].

	CFA 23				
week	all	a	b	c	d
June 03	2 (4)	-	-	-	2 (4)
June 10	3 (41)	-	-	-	3 (41)
June 17	5 (54)	-	-	-	5 (54)
June 24	4 (52)	-	-	-	4 (52)
July 01	2 (31)	-	-	-	2 (31)
July 08	7 (47)	4 (22)	2 (11)	-	1 (14)
July 15	13 (106)	6 (41)	2 (13)	-	4 (42)
July 22	4 (21)	-	3 (10)	-	1 (11)
July 29	7 (45)	4 (21)	1 (12)	-	1 (6)
Aug. 05	6 (31)	4 (21)	1 (5)	-	-
Aug. 12	7 (49)	1 (7)	2 (14)	-	4 (28)
Aug. 19	1 (6)	1 (6)	-	-	-
Aug. 26	8 (50)	5 (33)	3 (17)	-	-
Sept. 02	3 (25)	1 (11)	2 (14)	-	-
Sept. 09	1 (5)	1 (5)	-	-	-
Sept. 16	2 (8)	-	2 (8)	-	-
Sept. 23	2 (19)	-	2 (19)	-	-
Sept. 30	-	-	-	-	-
Oct. 07	-	-	-	-	-
Oct. 14	2 (24)	-	2 (24)	-	-
total	79 (618)	27 (167)	22 (147)	2 (16)	27 (283)

Table 15. Landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 24, 1978 - 2001.

Year	Active licenses/permits	TAC (t)	Landing statistics	Mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1978	-	-	-	-	-
1979	4	-	61	14.8	4.1
1980	10	-	70	12.8	5.5
1981	5	-	21	15.8	1.3
1982	7	-	62	10.1	6.1
1983	13	-	64	8.4	7.6
1984	13	-	52	9.2	5.6
1985	6	-	35	10.2	3.4
1986	7	-	49	11.9	4.1
1987	11	-	84	12.9	6.5
1988	13	-	163	15.7	10.4
1989	18	-	201	17.2	11.7
1990	19	-	543	33.3	16.3
1991	21	-	682	40.1	17.0
1992	22	-	743	38.5	19.3
1993	21	-	662	33.3	19.9
1994	21	-	682	33.4	20.4
1995	31	-	550	34.4	16.0
1996	27	569	560	57.1	9.8
1997	29	570	565	45.2	12.5
1998	33	823	745	62.0	12.0
1999		1,400	1,400	60.6	23.1
2000	79	4,374	4,300	84.9	50.6
2001	82	4,061	4,043	96.2	44.1
average (all)		-	710.3	33.0	14.2
average (97-01)		2,246	2,211	69.8	28.5

Table 16. Weekly landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 24, in 2001.

Week	Landings (kg)						CPUE (kg/trap haul)						Effort (total number of trap hauls)					
	all	permanent	temporary				all	permanent	Temporary				all	permanent	temporary			
			b	c	d	e			b	c	d	e			b	c	d	e
June 03	39,359	-	-	-	39,359	-	86.3	-	-	-	86.3	-	456	-	-	-	456	-
June 10	78,465	-	-	-	78,465	-	107.6	-	-	-	107.6	-	729	-	-	-	729	-
June 17	57,328	-	-	-	57,328	-	99.0	-	-	-	99.0	-	579	-	-	-	579	-
June 24	60,536	-	-	-	60,536	-	115.1	-	-	-	115.1	-	526	-	-	-	526	-
July 01	212,541	143,504	13,571	-	49,144	6,322	121.9	134.0	84.8	-	119.9	44.5	1,744	1,071	160	-	410	142
July 08	481,460	283,661	38,517	24,437	112,190	22,655	109.9	130.5	131.9	96.2	83.7	68.4	4,382	2,173	292	254	1,340	331
July 15	508,501	262,657	53,494	41,430	108,735	42,185	99.0	117.9	111.2	89.5	84.2	64.6	5,137	2,228	481	463	1,291	653
July 22	359,260	163,285	63,760	18,083	83,669	35,088	94.9	107.1	128.5	91.3	78.6	60.6	3,786	1,525	496	198	1,064	579
July 29	323,439	152,968	58,798	10,024	73,202	23,822	92.5	113.8	128.4	94.6	73.1	47.8	3,497	1,345	458	106	1,001	498
Aug. 05	266,808	102,932	46,330	8,480	68,415	40,651	93.4	113.9	126.6	90.2	83.4	61.0	2,856	903	366	94	820	666
Aug. 12	471,838	191,804	89,520	18,722	119,554	52,238	94.9	112.7	116.9	91.3	82.3	62.5	4,971	1,702	766	205	1,453	836
Aug. 19	336,774	163,052	37,175	22,971	72,474	41,102	88.4	107.7	102.0	105.6	72.3	59.2	3,808	1,514	364	217	1,003	694
Aug. 26	225,399	90,261	2,030	23,475	75,366	34,267	95.6	117.2	101.5	108.7	94.3	62.1	2,357	770	20	216	799	552
Sept. 02	82,276	22,517	-	4,634	33,485	21,640	83.3	108.8	-	220.7	69.3	78.7	988	207	-	21	483	275
Sept. 09	162,162	37,515	11,962	22,742	56,148	21,833	92.4	155.0	107.8	122.3	61.6	87.3	1,755	242	111	186	911	250
Sept. 16	133,915	20,588	-	6,804	88,652	17,871	70.8	126.3	-	91.9	61.1	77.8	1,893	163	-	74	1,452	230
Sept. 23	115,047	2,052	27,478	1,987	76,534	6,996	84.0	57.0	165.5	32.6	76.5	58.8	1,369	36	166	61	1,001	119
Sept. 30	75,683	16,757	30,052	4,527	17,036	2,996	101.5	112.5	125.7	52.8	87.8	74.9	746	149	239	86	194	40
Oct. 07	76,978	10,405	37,100	930	5,228	23,315	97.9	69.8	150.8	29.1	91.7	77.2	786	149	246	32	57	302
Oct. 14	44,474	1,765	20,068	930	2,732	18,979	90.2	46.4	150.8	35.8	85.4	82.4	493	38	133	26	32	230
Oct. 21	72,151	9,565	36,497	-	8,794	17,295	103.0	63.3	132.2	-	109.9	95.6	700	151	276	-	80	181
Oct. 28	18,819	4,278	6,677	-	4,804	-	58.1	37.5	54.9	-	120.1	-	324	114	122	-	40	-
Nov. 04	8,339	-	-	-	8,339	-	148.9	-	-	-	148.9	-	56	-	-	-	56	-
Nov. 11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nov. 18	27,435	-	-	-	27,435	-	145.2	-	-	-	145.2	-	189	-	-	-	189	-
Nov. 25	3,471	-	-	-	3,471	-	111.9	-	-	-	112.0	-	31	-	-	-	31	-
total	4,042,628[2]	1,654,182[2]	573,029	210,176	1,334,157	429,255	96.2	116.0	122.6	94.1	83.7	65.4	44,080	14,482	4,673	2,234	15,936	6,568

[2] Total landings from statistic, DFO.

Table 17. Weekly landings, catch rate and effort statistics for Snow Crab in Crab Fishing Area 24, sub-area D, in 2001.

CFA 24 sub-area 24D									
week	Landings (kg)			CPUE (kg/trap haul)			Effort (total number of trap hauls)		
	all	sable	slope	all	sable	slope	all	sable	slope
June 03	39,359	39,359	-	86.3	86.3	-	456	456	-
June 10	78,465	78,465	-	107.6	107.6	-	729	729	-
June 17	57,328	57,328	-	99.0	99.0	-	579	579	-
June 24	60,536	60,536	-	115.1	115.1	-	526	526	-
July 01	49,144	49,144	-	119.9	119.9	-	410	410	-
July 08	112,190	112,190	-	83.7	83.7	-	1,340	1,340	-
July 15	108,735	108,735	-	84.2	84.2	-	1,291	1,291	-
July 22	83,669	83,669	-	78.6	78.6	-	1,064	1,064	-
July 29	73,202	73,202	-	73.1	73.1	-	1,001	1,001	-
Aug. 05	68,415	68,415	-	83.4	83.4	-	820	820	-
Aug. 12	119,556	119,556	-	82.3	82.3	-	1,453	1,453	-
Aug. 19	72,474	72,474	-	72.3	72.3	-	1,003	1,003	-
Aug. 26	75,366	75,366	-	94.3	94.3	-	799	799	-
Sept. 02	33,485	33,485	-	69.3	69.3	-	483	483	-
Sept. 09	56,148	56,148	-	61.6	61.6	-	911	911	-
Sept. 16	88,652	88,652	-	61.1	61.1	-	1,452	1,452	-
Sept. 23	76,534	70,201	6,333	76.5	80.8	51.1	1,001	869	124
Sept. 30	17,036	16,572	1,954	87.8	85.4	32.6	254	194	60
Oct. 07	5,228	1,496	3,732	91.7	62.3	113.1	57	24	33
Oct. 14	2,732	-	2,732	85.4	-	85.4	32	-	32
Oct. 21	8,794	-	8,794	109.9	-	109.9	80	-	80
Oct. 28	4,804	-	4,804	120.1	-	120.1	40	-	40
Nov. 04	8,339	-	8,339	148.9	-	148.9	56	-	56
Nov. 11	-	-	-	-	-	-	-	-	-
Nov. 18	27,435	-	27,435	145.2	-	145.2	189	-	189
Nov. 25	3,471	-	3,471	112.0	-	112.0	31	-	31
total	1,334,157	1,264,993	70,654	83.7	82.6	101.5	16,003	15,307	696

Table 18. Seasonal catch composition, in percentage, from at-sea samples for Crab Fishing Area 24 in 2001.

a) Catch composition in CFA 24, all sub-areas (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
60	532	< 95 mm	3.5	8.7	0.8	0.2	4.2	8.9	13.1
		> 95 mm	17.8	61.4	2.0	5.7	19.8	67.0	86.9
		total	21.3	70.1	2.8	5.8	24.0	76.0	100.0

b) Catch composition in CFA 24, sub-area A (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
22	165	< 95 mm	2.8	10.0	0.3	0.0	3.1	10.0	13.1
		> 95 mm	16.1	59.4	2.1	9.4	18.1	68.8	86.9
		total	18.9	69.3	2.3	9.5	21.2	78.8	100.0

c) Catch composition in CFA 24, sub-area B (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
8	52	< 95 mm	2.4	3.8	0.4	0.0	2.7	3.9	6.6
		> 95 mm	16.0	73.3	0.8	3.3	16.8	76.6	93.4
		total	18.4	77.1	1.1	3.3	19.6	80.4	100.0

d) Catch composition in CFA 24, sub-area C (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
2	9	< 95 mm	0.6	8.9	0.6	0.3	1.1	9.2	10.3
		> 95 mm	3.9	73.3	1.7	10.8	5.6	84.2	89.7
		total	4.4	82.2	2.2	11.1	6.7	93.3	100.0

e) Catch composition in CFA 24, sub-area D (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
16	204	< 95 mm	4.3	4.8	1.4	0.2	5.7	5.1	10.8
		> 95 mm	25.1	57.4	3.0	3.6	28.2	61.1	89.2
		total	29.5	62.3	4.4	3.9	33.9	66.1	100.0

f) Catch composition in CFA 24, sub-area E (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
12	90	< 95 mm	3.6	19.5	0.5	0.4	4.1	19.9	23.9
		> 95 mm	5.9	64.8	0.6	4.8	6.5	69.6	76.1
		total	9.5	84.3	1.0	5.2	10.6	89.4	100.0

Table 19a. Seasonal and weekly soft-shell percentages for Crab Fishing Area 24, from at-sea samples in 2001.

	CFA 24					
week	all	a	b	c	d	e
June 03	-	-	-	-	-	-
June 10	2.6	-	-	-	2.6	-
June 17	-	-	-	-	-	-
June 24	0.3	-	-	-	0.3	-
July 01	8.6	-	-	-	9.8	1.7
July 08	4.3	4.4	3.3	-	5.2	2.1
July 15	14.6	20.3	-	-	17.0	9.9
July 22	13.6	19.0	0.5	-	12.0	5.1
July 29	9.0	17.3	5.7	-	8.1	5.0
Aug. 05	14.5	21.5	7.3	-	4.7	12.4
Aug. 12	26.3	29.6	-	-	5.7	7.5
Aug. 19	9.2	1.4	-	-	-	
Aug. 26	4.4	-	4.4	-	-	-
Sept. 02	4.7	-	4.7	-	-	-
Sept. 09	-	-	-	-	-	-
Sept. 16	1.8	-	-	-	1.8	-
Sept. 23	-	-	-	-	-	-
Sept. 30	-	-	-	-	-	-
Oct. 07	-	-	-	-	-	-
Oct. 14	3.8	-	-	-	-	-
total	13.6	20.9	4.3	13.6	8.0	7.7

Table 19b. Seasonal and weekly soft-shell (in number) for Crab Fishing Area 24, from at-sea samples in 2001[number of trips (number of traps)].

	CFA 24					
week	all	a	b	c	d	e
June 03	-	-	-	-	-	-
June 10	1 (8)	-	-	-	1 (8)	-
June 17	-	-	-	-	-	-
June 24	1 (9)	-	-	-	1 (9)	-
July 01	3 (36)	-	-	-	2 (26)	1 (10)
July 08	6 (53)	3 (21)	1 (6)	-	1 (22)	1 (4)
July 15	3 (34)	1 (13)	-	-	1 (17)	-
July 22	10 (79)	5 (24)	1 (11)	-	3 (31)	1 (13)
July 29	9 (72)	2 (20)	1 (8)	-	2 (12)	4 (32)
Aug. 05	8 (85)	3 (31)	2 (8)	-	2 (36)	1 (10)
Aug. 12	11 (67)	7 (42)	-	-	1 (10)	3 (15)
Aug. 19	3 (25)	1 (14)	-	-	-	1 (6)
Aug. 26	1 (4)	-	1 (4)	-	-	-
Sept. 02	1 (11)	-	1 (11)	-	-	-
Sept. 09	-	-	-	-	-	-
Sept. 16	2 (33)	-	-	-	2 (33)	-
Sept. 23	-	-	-	-	-	-
Sept. 30	-	-	-	-	-	-
Oct. 07	-	-	-	-	-	-
Oct. 14	1 (4)	-	-	-	-	-
total	60 (520)	22 (165)	8 (52)	2 (9)	16 (204)	12 (90)

Table 20. Biomass estimation in Crab fishing Areas 21 and 22 based on catch-effort method in 2001.

Areas considered	Capturability	Biomass at the beginning of the fishery (t)	Standard deviation	Percentiles	
				5%	95%
22o	0.000443259	449	2553.89	445,018.4	453,038.8
21 and 22n	0.000078345	1,508	8917.91	422,236.2	429,332.0

- 22o: outer area or Glace Bay hole
- 22n: Northern area or north Smoky

Table 21. Soft and white crab health conditions after the mortality experiment, in 2001, by maturity and hardness.

a) Soft and white crab condition (in percentage).

Health condition	soft shell crab			white shell crab			soft and white shell crab		
	adolescent	adult	ado. + adult	adolescent	adult	ado. + adult	adolescent	adult	ado. + adult
A1*	62	40	43	-	56	58	63	43	46
A2 *	21	25	25	-	25	23	19	25	24
A3 *	13	17	16	-	13	13	13	16	16
B*	2	14	12	-	4	3	2	12	10
C*	2	4	4	-	2	2	2	4	3
Total	100	100	100	100	100	100	100	100	100

*Appendix 2

b) Soft and white crab condition (in number).

Health condition	soft shell crab			white shell crab			soft and white shell crab		
	adolescent	adult	ado. + adult	adolescent	adult	ado. + adult	adolescent	adult	ado. + adult
A1*	29	103	132	4	31	35	33	134	167
A2 *	10	65	75	0	14	14	10	79	89
A3 *	6	44	50	1	7	8	7	51	58
B*	1	35	36	0	2	2	1	37	38
C*	1	10	11	0	1	1	1	11	12
Total	47	257	304	5	55	60	52	312	364

*Appendix 2

Table 22. Mean number of crabs by depth range for exploratory trap survey in Crab Fishing Area 23, in 2001.

	Depth range (meters)			
	75 – 150	151 – 250	251 – 350	351 – 404
Mean	61.3	10.1	3.9	1.8
Standard Error	6.8	3.9	1.6	0.8
Median	40.0	0.0	0.0	0.0
Mode	40.0	0.0	0.0	0.0
Standard Deviation	61.7	32.6	13.2	4.9
Sample Variance	3,808.5	1,064.4	175.0	24.5
Kurtosis	0.9	31.5	34.7	11.0
Skewness	1.3	5.2	5.5	3.4
Range	255	230	95	23
Minimum	0	0	0	0
Maximum	255	230	95	23
Sum	5,090	716	264	70
Count	83	71	68	38

Table 23. Mean number of crabs by depth range and month for exploratory trap survey in Crab Fishing Area 23, in 2001.

	Month and depth (meters)							
	Aug. (100)	Oct. (100)	Aug. (200)	Oct. (200)	Aug. (300)	Oct. (300)	Aug. (400)	Oct. (400)
Mean	102.2	39.4	19.1	8.1	7.5	6.7	3.7	1.6
Standard Error	14.5	8.0	12.7	3.6	6.0	2.8	2.1	1.1

Table 24. Biomass estimates (t) of adult male snow crab ≥95mm carapace width in northeastern Nova Scotia (at the time of each survey).

	Spring survey (old mask)			Spring survey (new mask)			Fall survey (new mask)		
year	Soft (t)	Hard (t)	Total	Soft (t)	Hard (t)	Total	Soft (t)	Hard (t)	Total
1998	1,434 ± 287	1,215 ± 2,612	2,649 ± 3,899	-	-	-	-	-	-
1999	1,101 ± 1,167	1,200 ± 1,596	2,301 ± 2,763	-	-	-	-	-	-
2000	210 ± 502	2,148 ± 1,783	2,358 ± 2,285	307 ± 504	2,619 ± 1,598	2,926 ± 2,102	-	-	-
2001	-	-	-	25 ± 194	2,905 ± 737	2,930 ± 931	1,532 ± 494	2,450 ± 1,197	3,982 ± 1,691

Table 25. Comparison of biomass estimates (t) of adult male snow crab ≥95mm CW in May, September and the calculated July (back calculation based on the fisheries and the September data).

	May	September	Landings/mortality	July (est.)
Soft	25 ± 194	1,532 ± 494	79t	1,611t
Hard	2,905 ± 737	2,450 ± 1,197	1,065t	3,515t
total	2,930 ± 931	3,982 ± 1,691	1,144t	5,126t

Table 26. Biomass estimates (t) of adult male snow crab ≥95mm carapace width in southeastern Nova Scotia, based on the total surveyed area covered that given year and at the time of the survey.

	Old mask			New mask		
year	Soft (t)	Hard (t)	Total	Soft (t)	Hard (t)	Total
1997	10,335 ± 5,126	12,657 ± 6,518	22,992 ± 11,657	-	-	-
1998	1,415 ± 4,122	24,880 ± 12,017	26,295 ± 16,139	-	-	-
1999	8,624 ± 5,571	23,533 ± 7,860	32,157 ± 13,431	-	-	-
2000	5,957 ± 1,549	22,982 ± 11,950	28,939 ± 13,499	8,422 ± 3,744	25,954 ± 7,450	34,376 ± 11,194
2001	±	±	±	8,541 ± 3,500	24,597 ± 2,964	33,139 ± 6,464

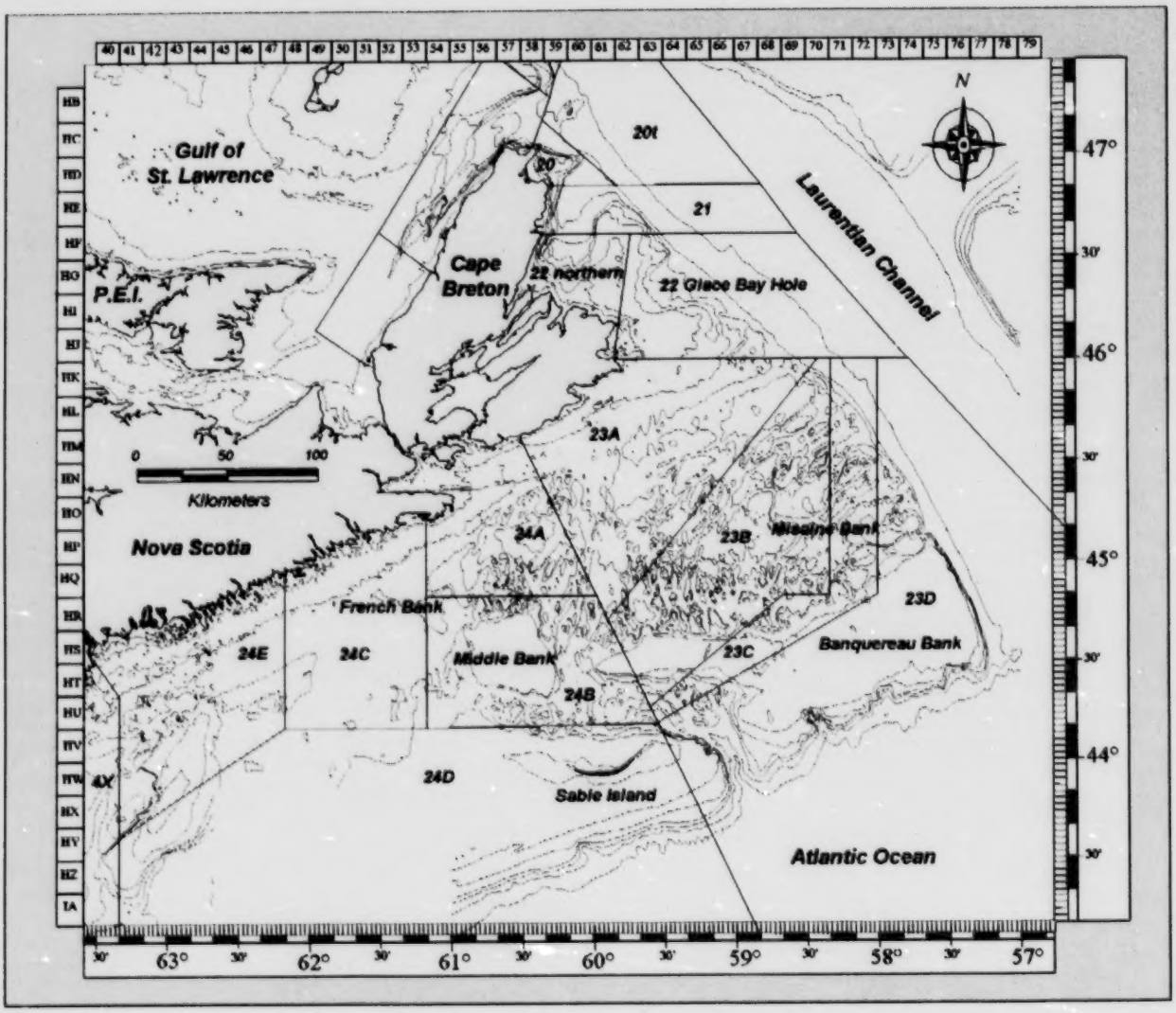


Figure 1. Snow Crab management sub-areas off eastern Nova Scotia.

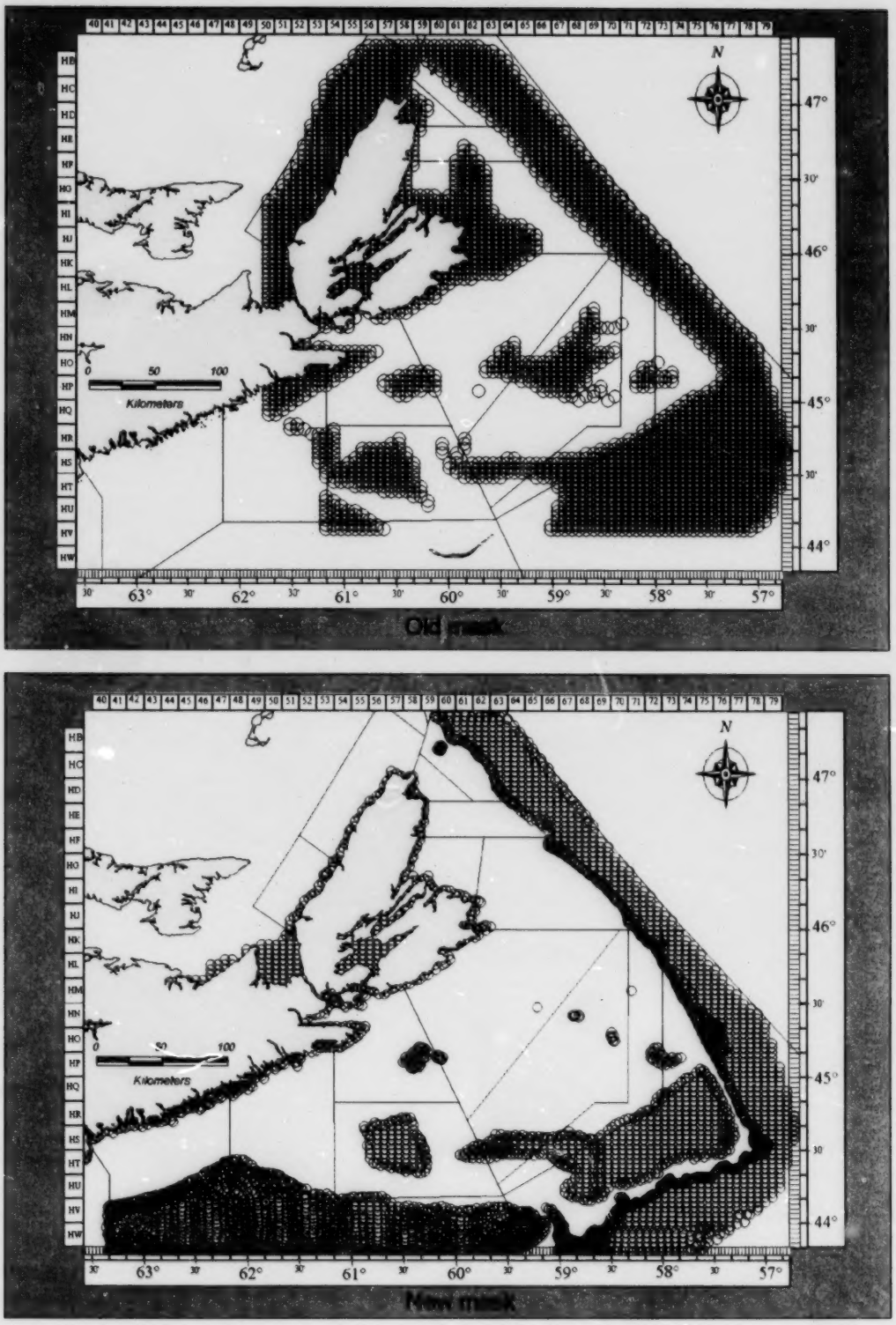


Figure 2. Old mask versus new mask with the pseudo-zeros used for kriging.

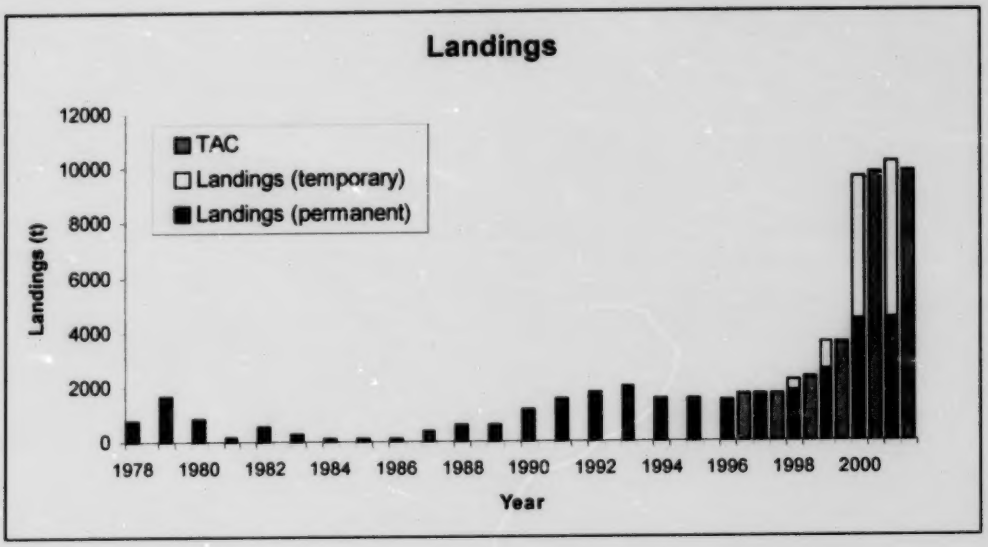


Figure 3. Snow Crab landings (t) in eastern Nova Scotia from 1978 to 2001.

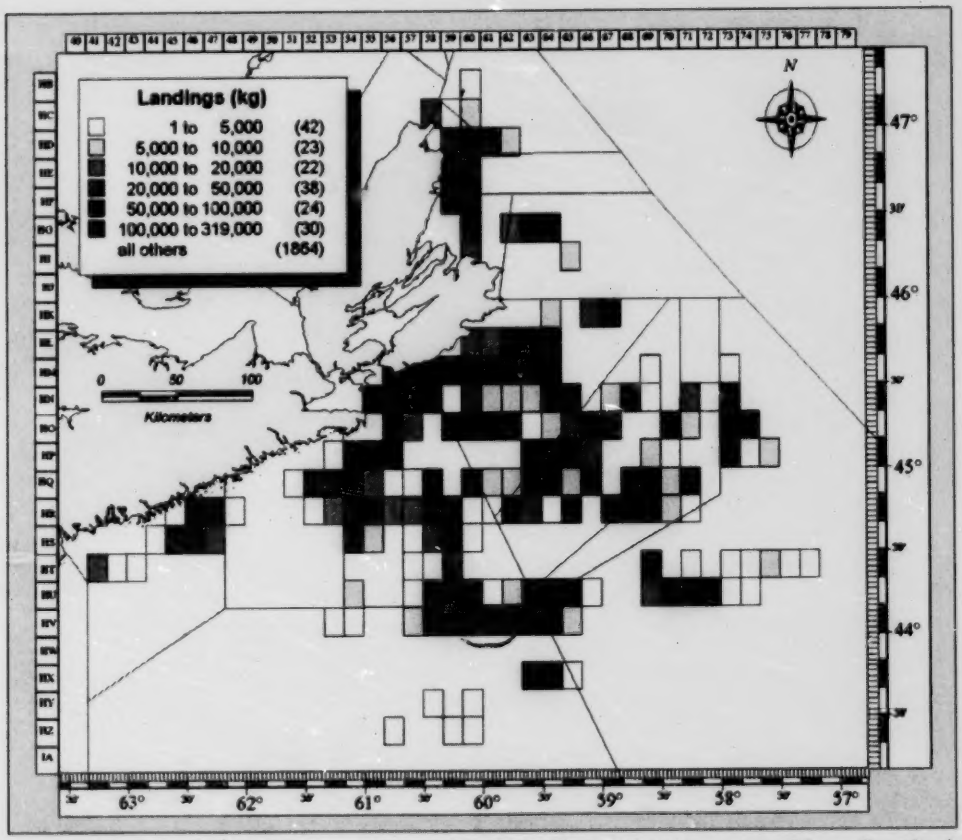


Figure 4. Seasonal distribution of Snow Crab landings (kg) in eastern Nova Scotia, in 2001.

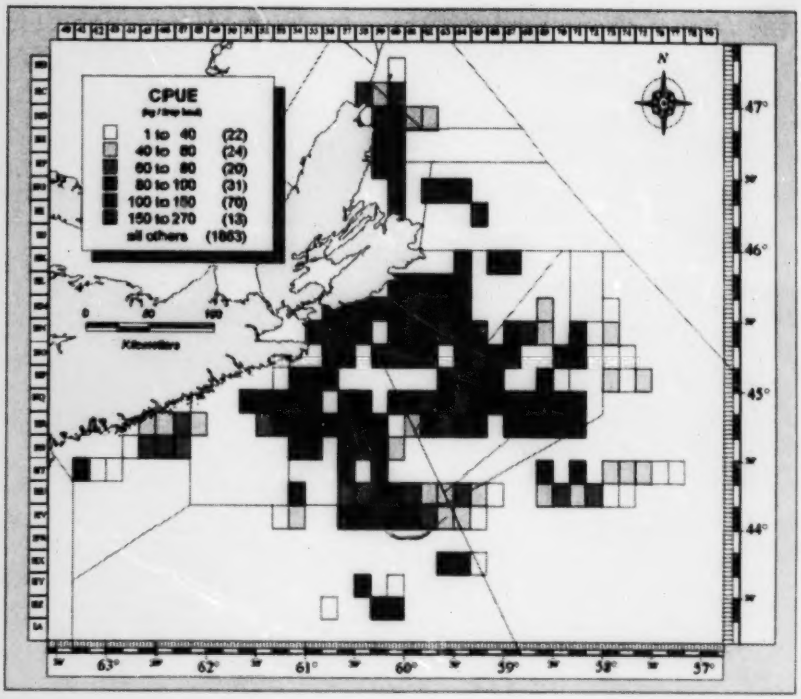


Figure 5. Seasonal distribution of CPUE (kg / trap haul) in eastern Nova Scotia in 2001.

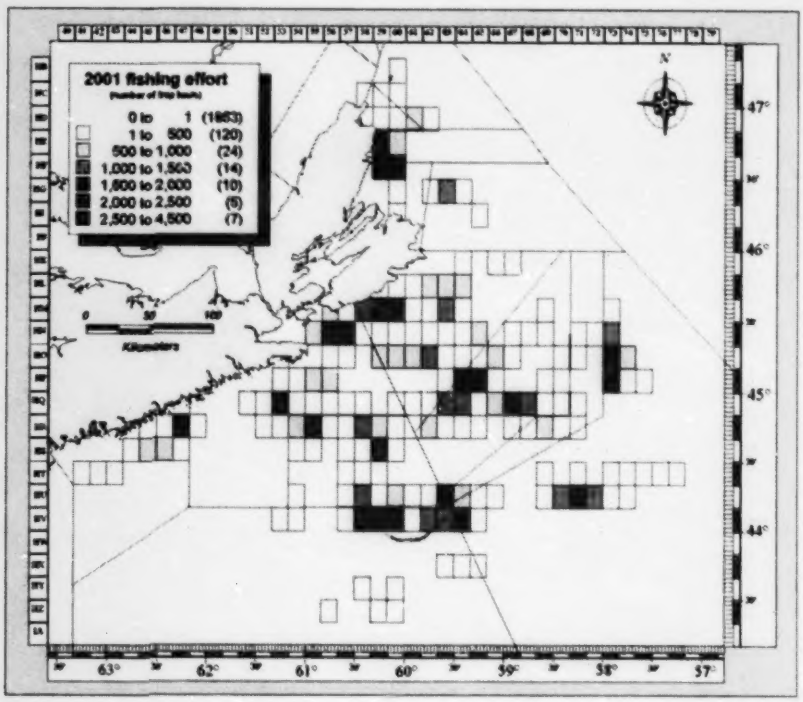


Figure 6. Seasonal distribution of effort (# of trap hauls) in eastern Nova Scotia in 2001.

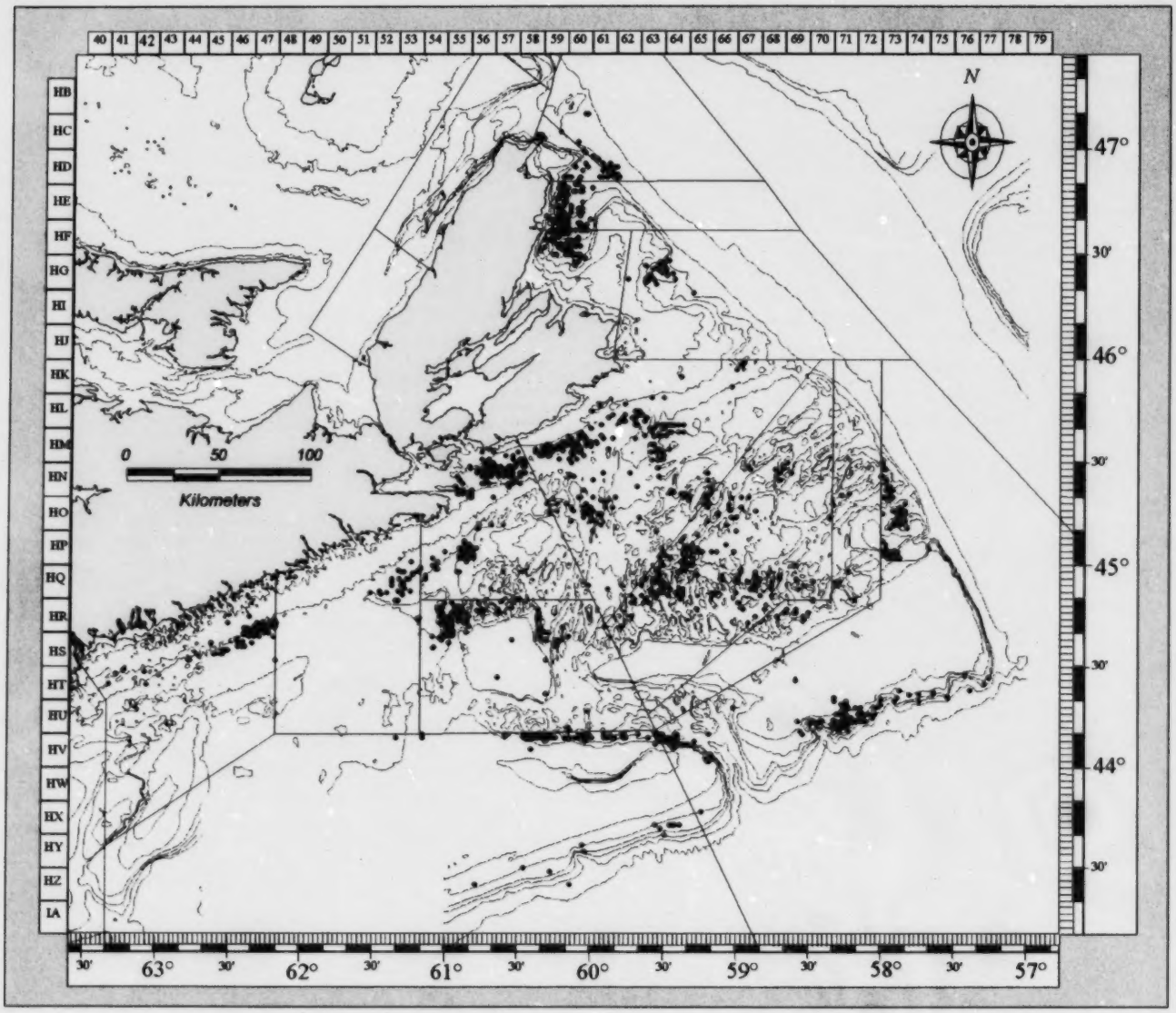


Figure 7. Reported logbook positions in eastern Nova Scotia in 2001.

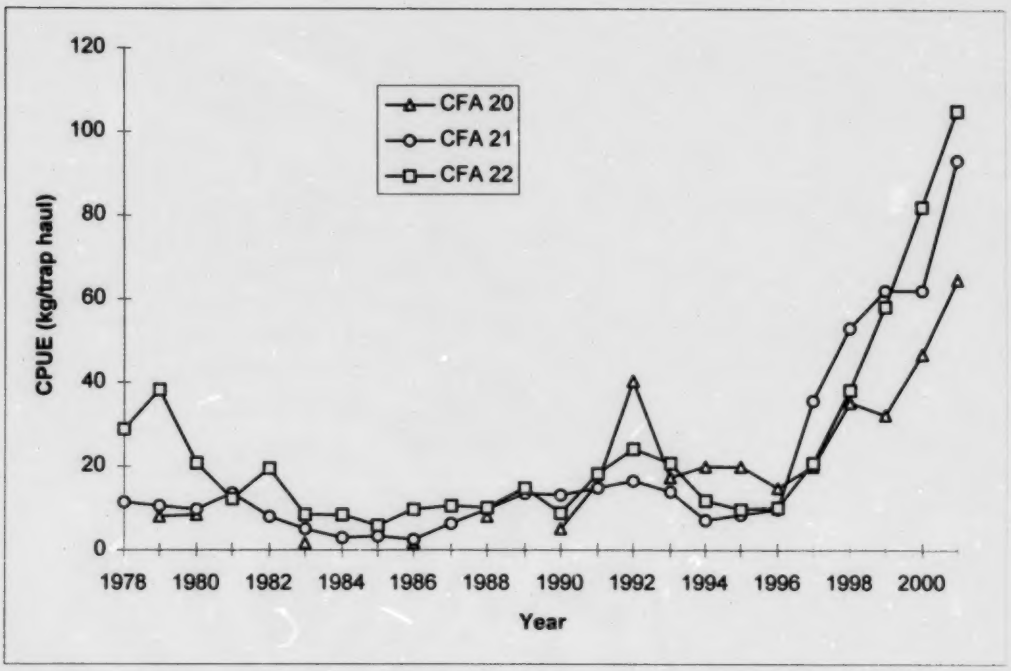


Figure 8. Catch per unit of effort for Crab Fishing Areas (CFA) 20, 21 and 22 from 1978 to 2001.

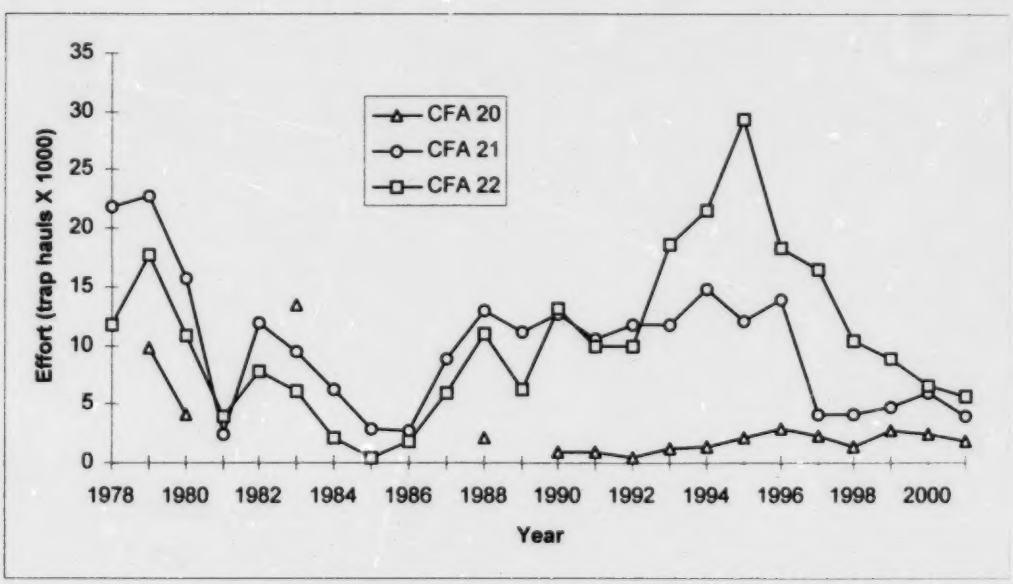


Figure 9. Fishing effort for Crab Fishing Areas (CFA) 20, 21 and 22 from 1978 to 2001.

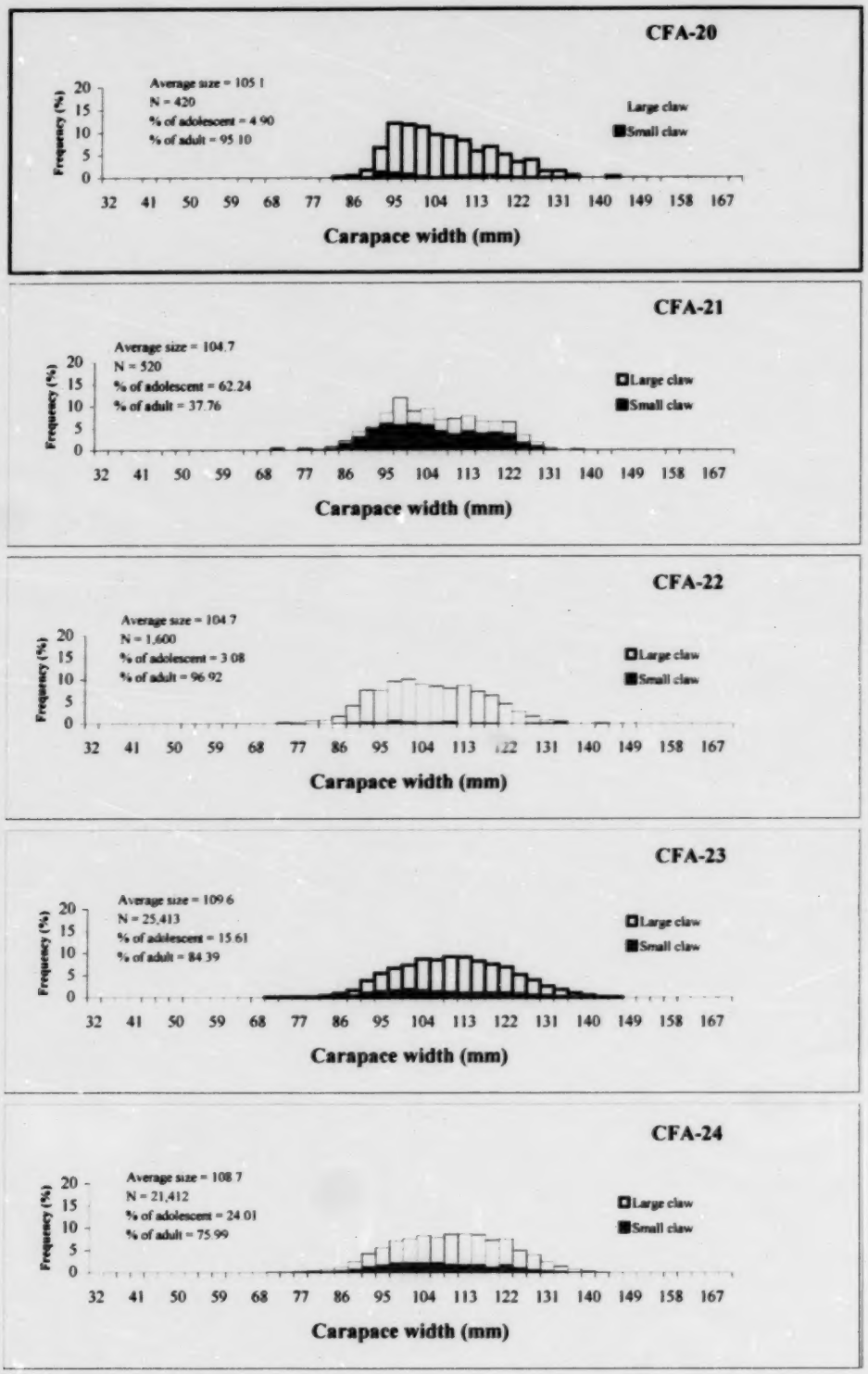


Figure 10. Size frequency distribution from sea sampling, in 2001, carried out in eastern Nova Scotia for Snow Crab.

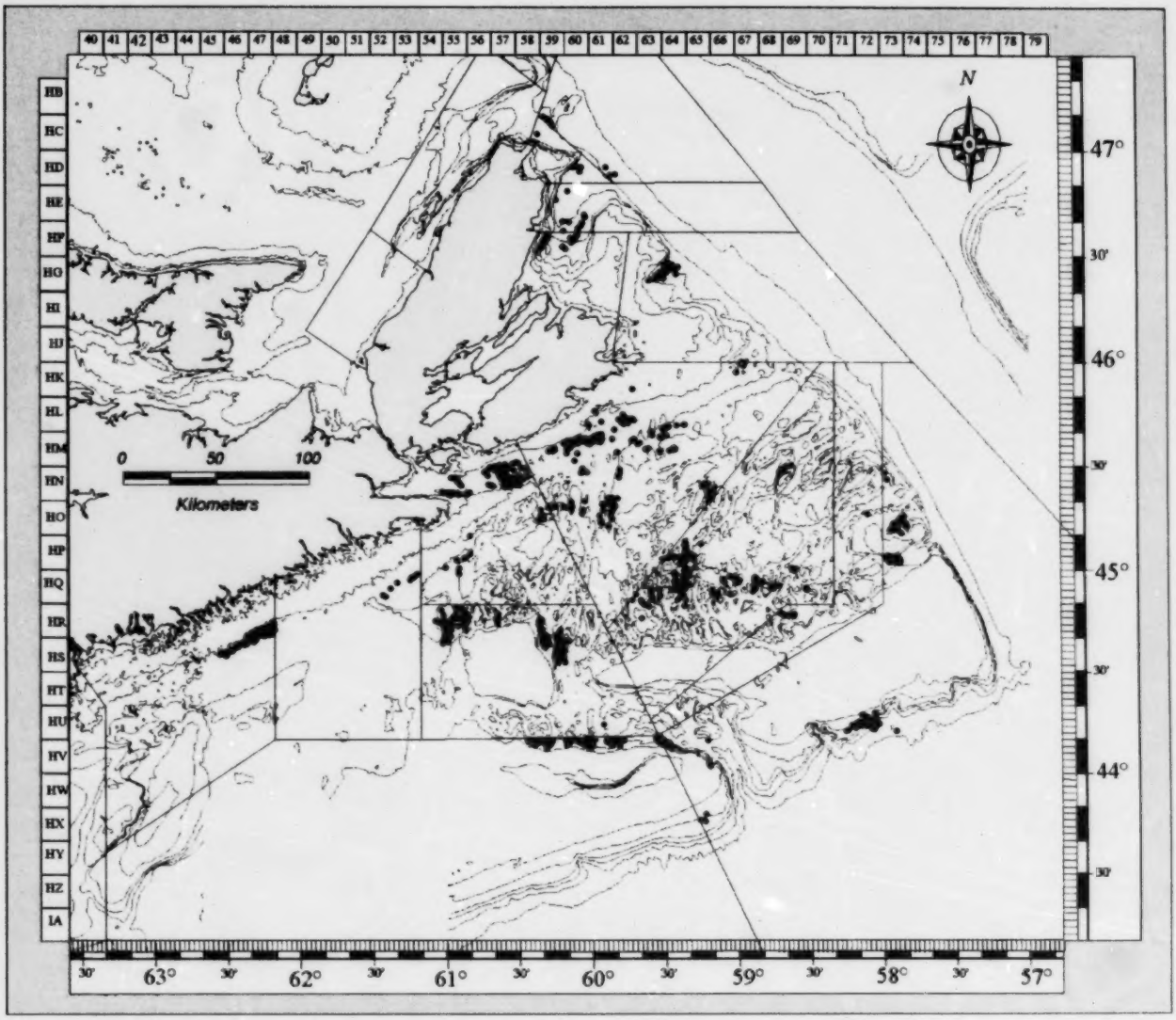


Figure 11. Reported observer positions in eastern Nova Scotia in 2001.

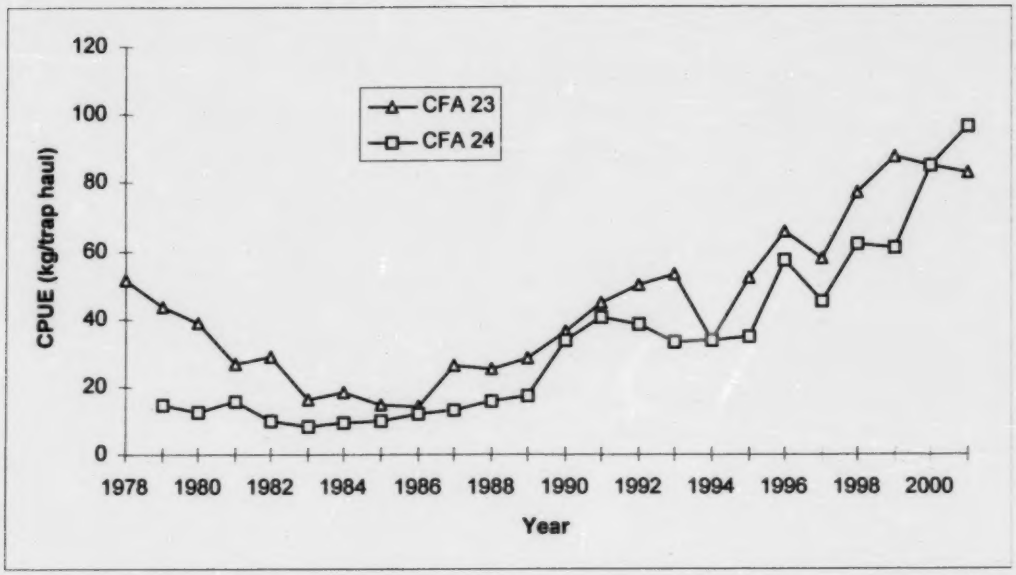


Figure 12. Catch per unit of effort for Crab Fishing Areas (CFAs) 23 and 24 from 1978 to 2001.

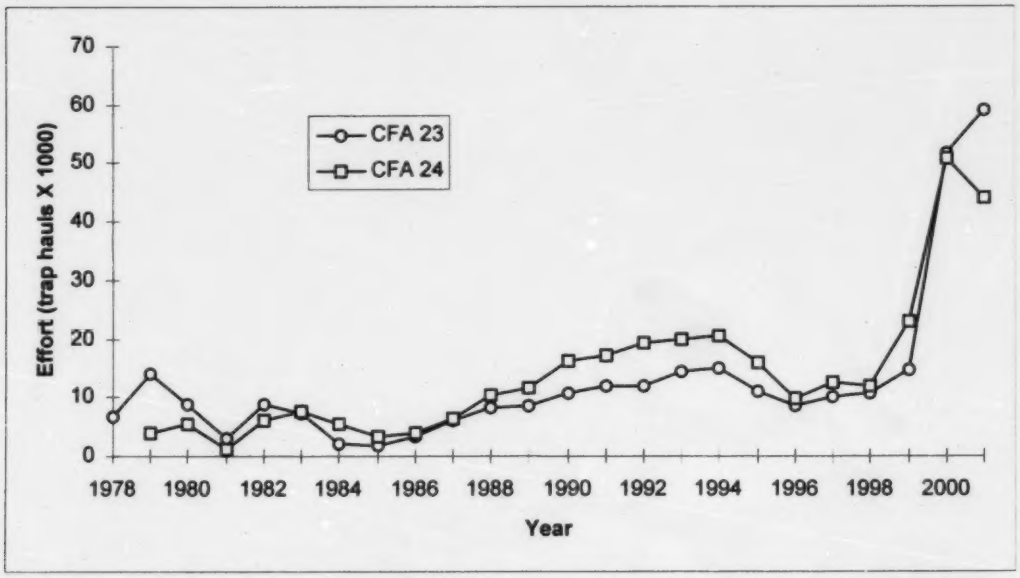


Figure 13. Fishing effort for Crab Fishing Areas (CFAs) 23 and 24 from 1978 to 2001.

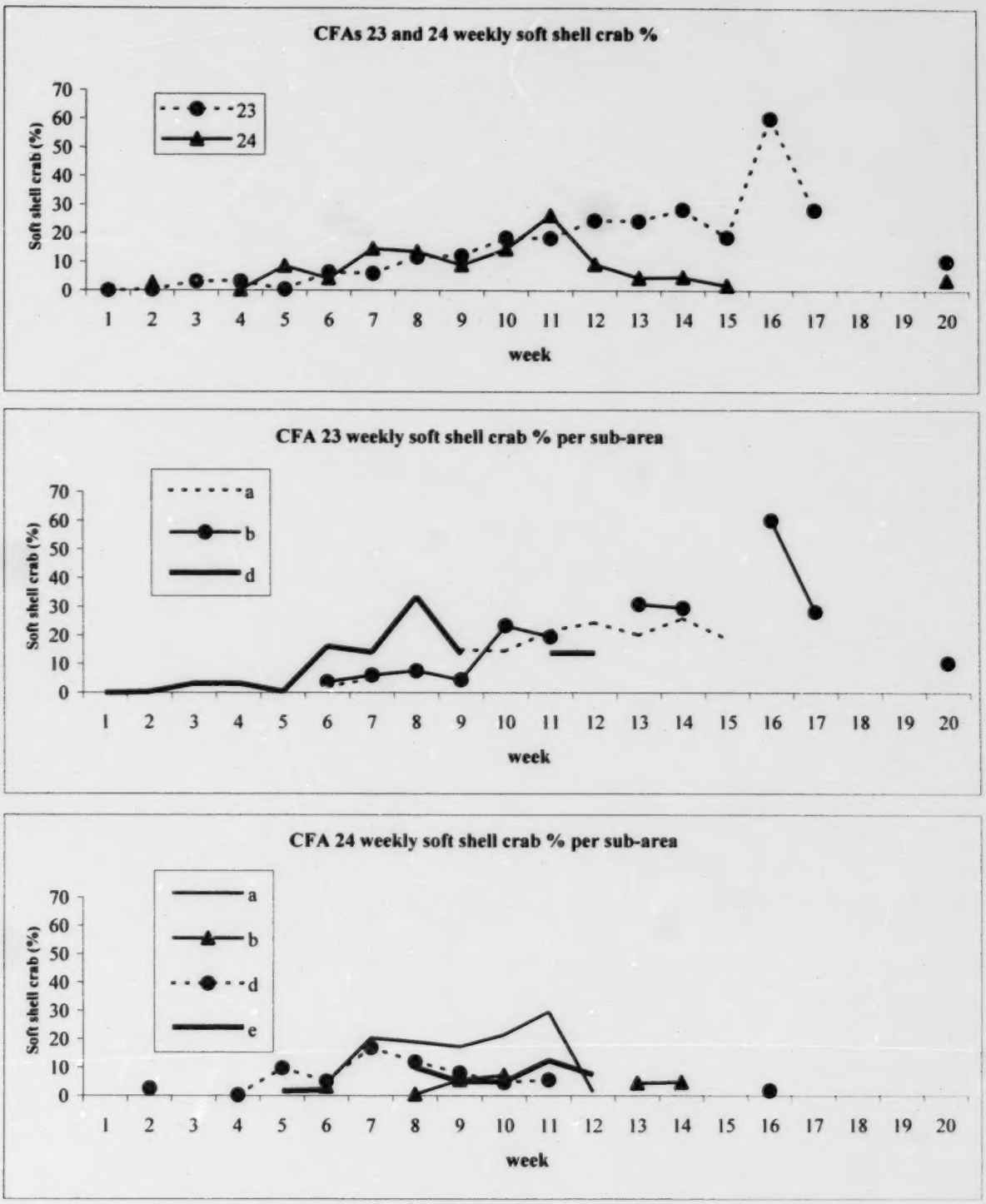


Figure 14. Weekly soft-shell crab (%) in each sub-area for Crab Fishing Areas (CFAs) 23 and 24 in 2001.

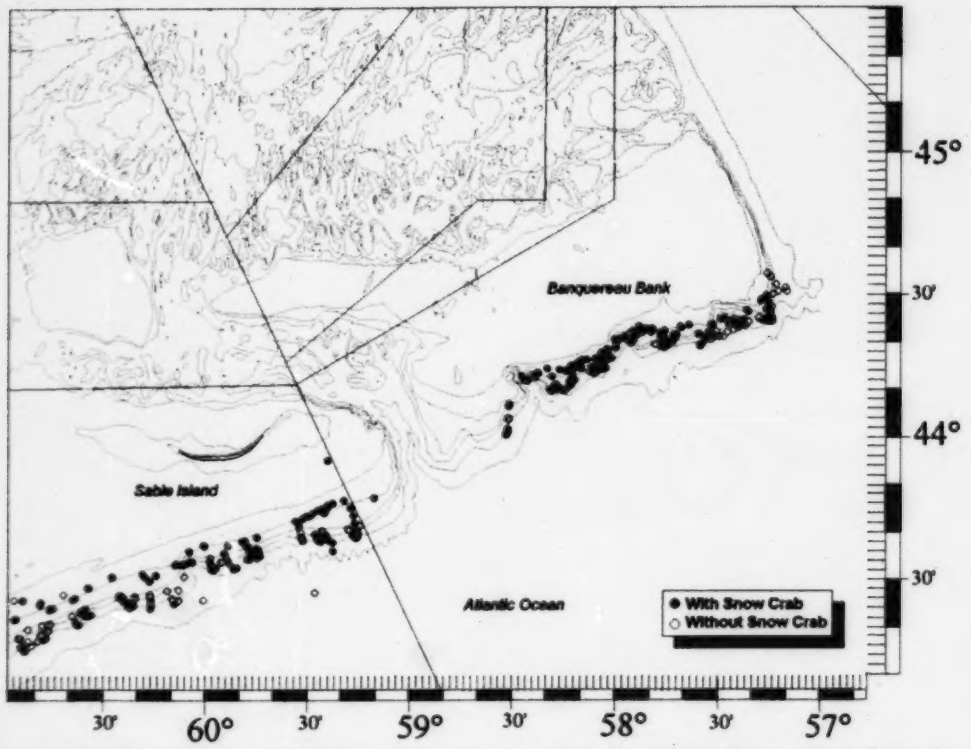


Figure 15. Distribution of fishing set positions with and without Snow Crab from the exploratory trap survey in Crab Fishing Areas (CFAs) 23 and 24 in 2001.

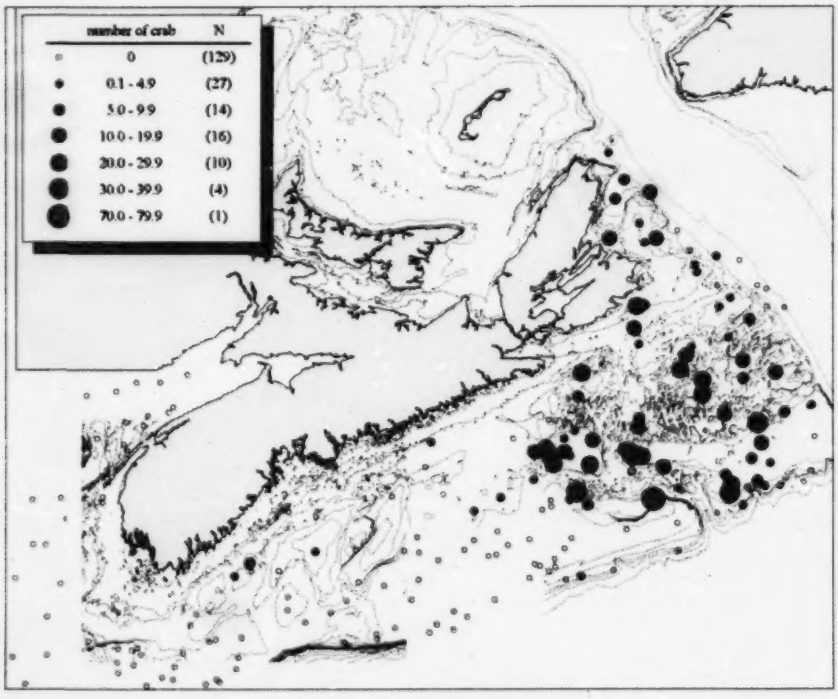


Figure 16. Distribution map showing number of crab per standard tow during the July 2001 groundfish survey.

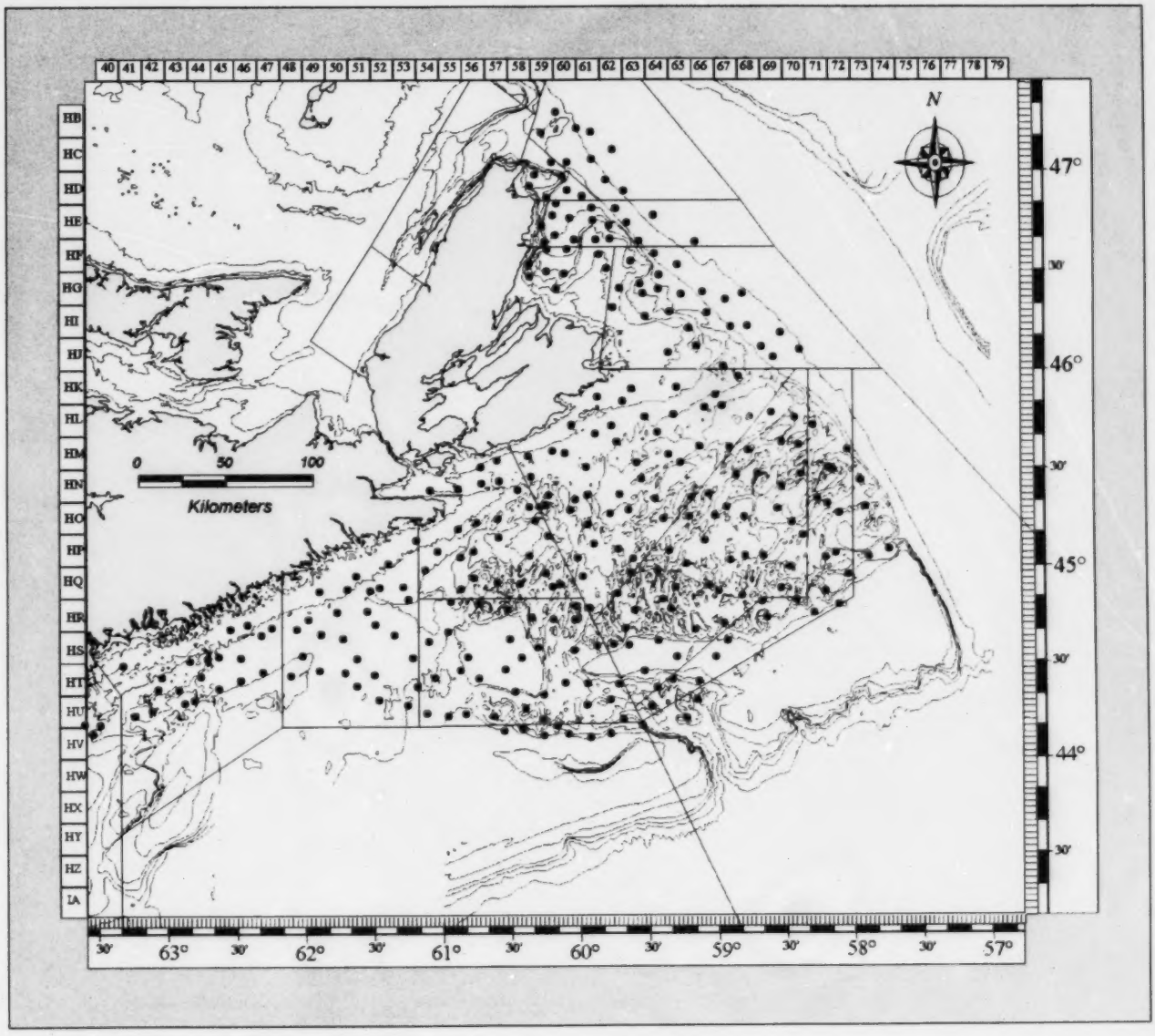


Figure 17. Location of Snow Crab trawl survey stations (N=303) in 2001.

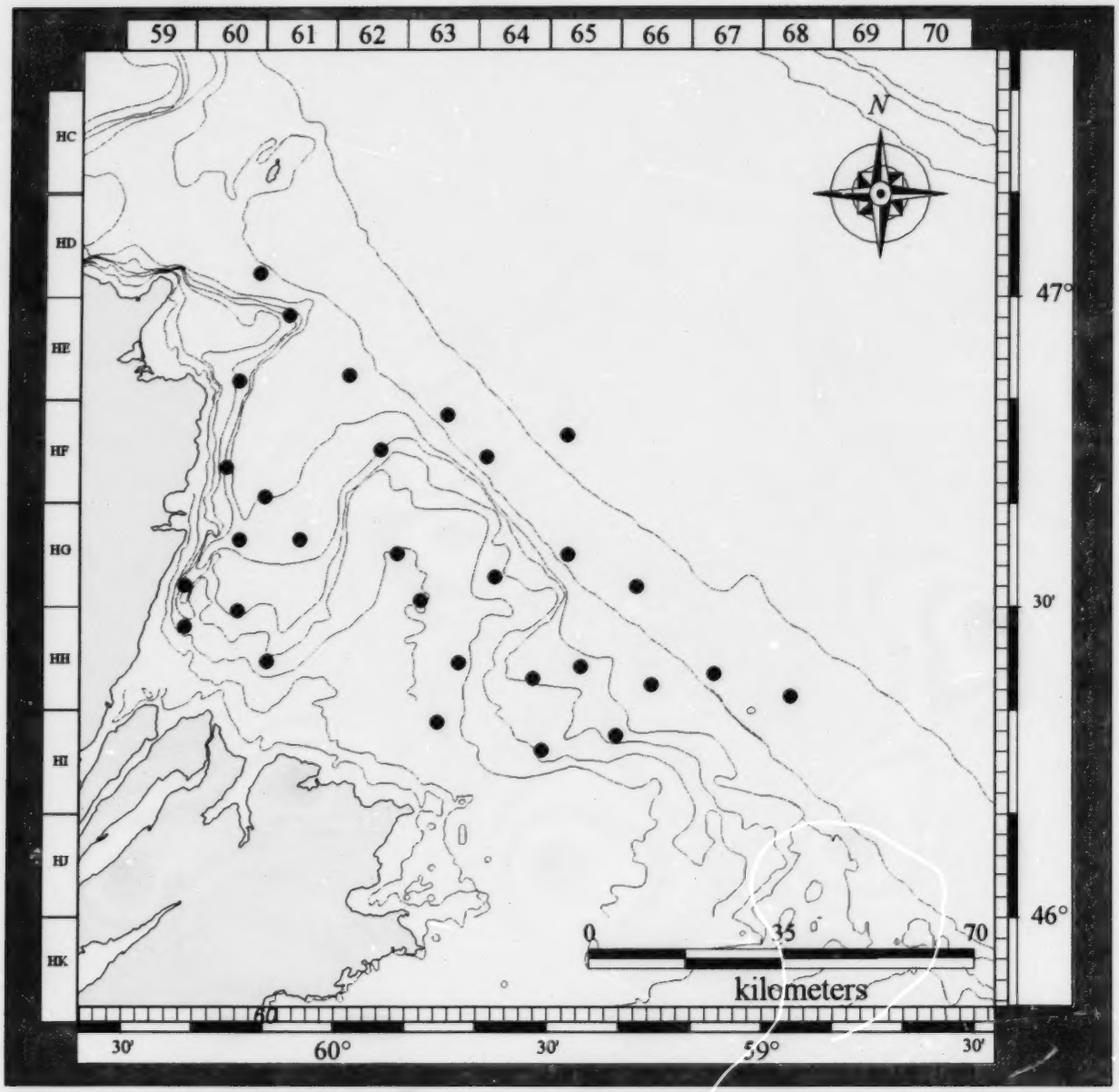


Figure 18. Location of trawl survey stations (n=30) sampled in September 2001.

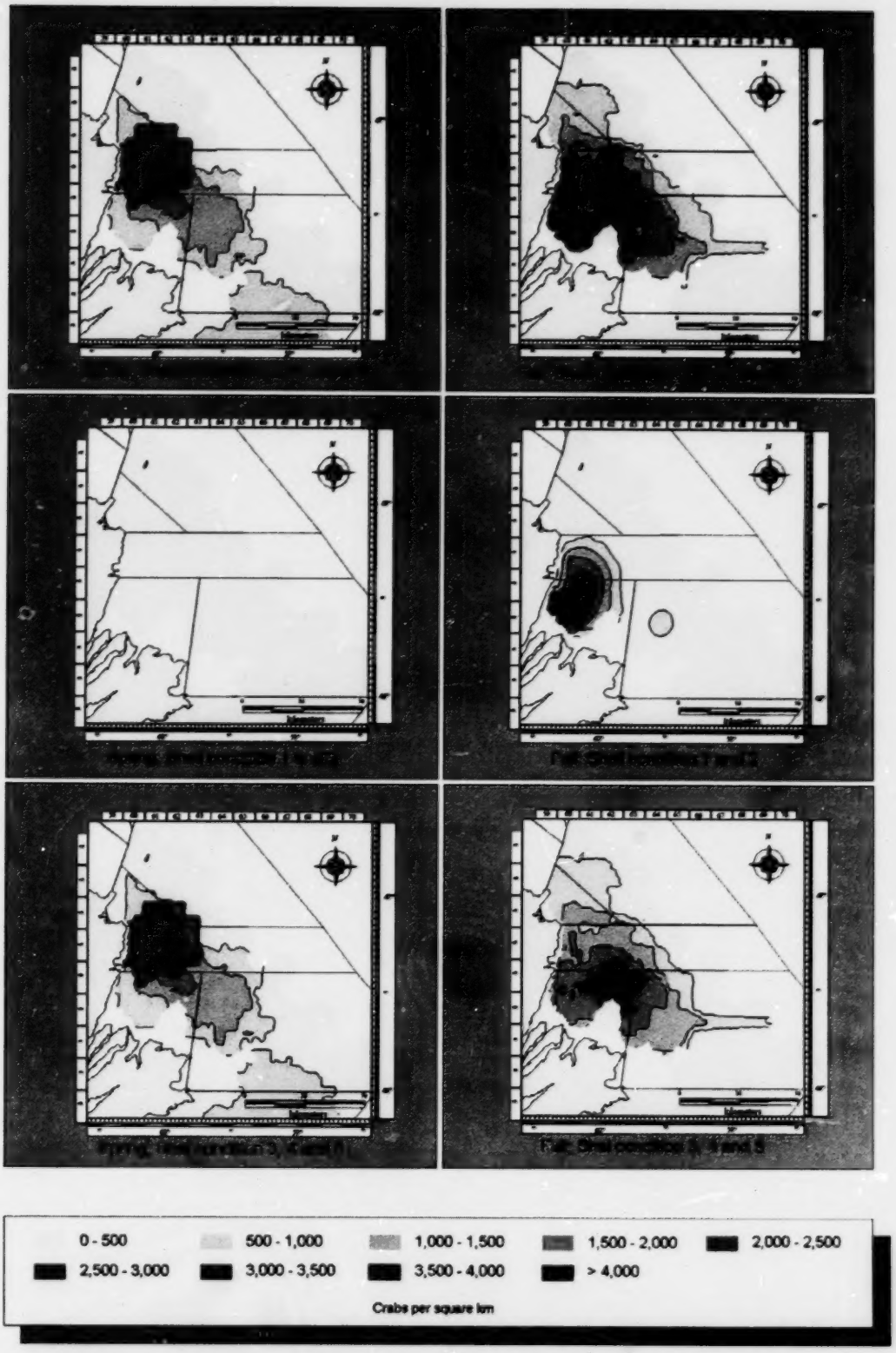


Figure 19. Adult male (≥ 95 mm carapace width) density distribution from the spring and fall 2001 surveys in northeastern Nova Scotia.

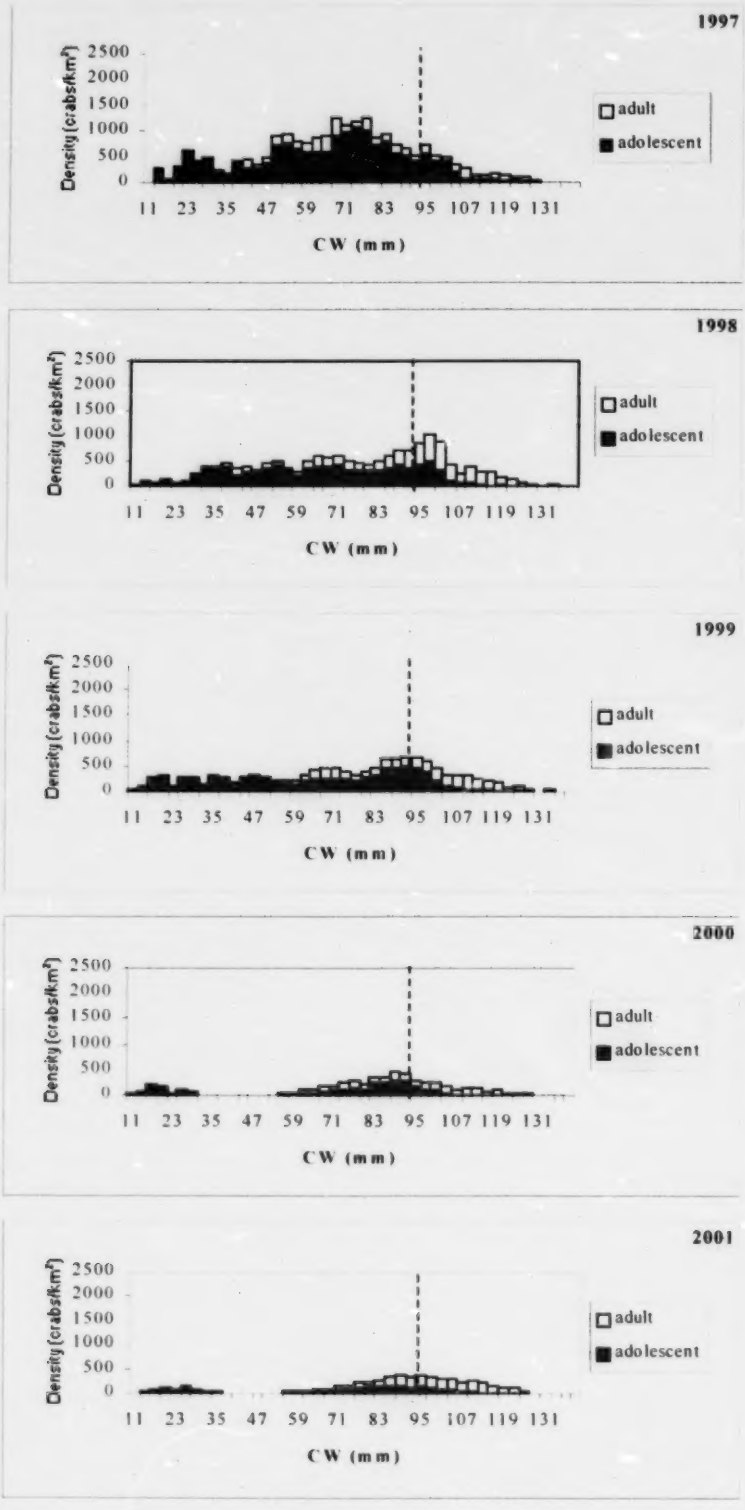


Figure 20. Survey size frequency of male Snow Crab in northeastern Nova Scotia from 1997 to 2001 (1997; CFA 22 only).

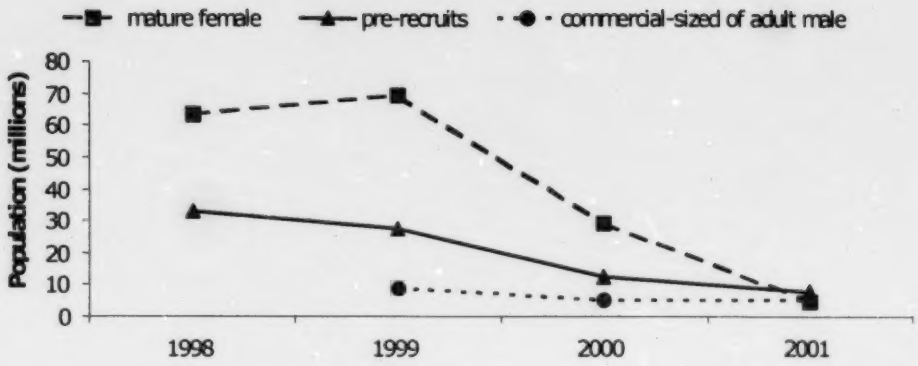


Figure 21. Number of mature females, pre-recruits and commercial-sized adult males in northeastern Nova Scotia.

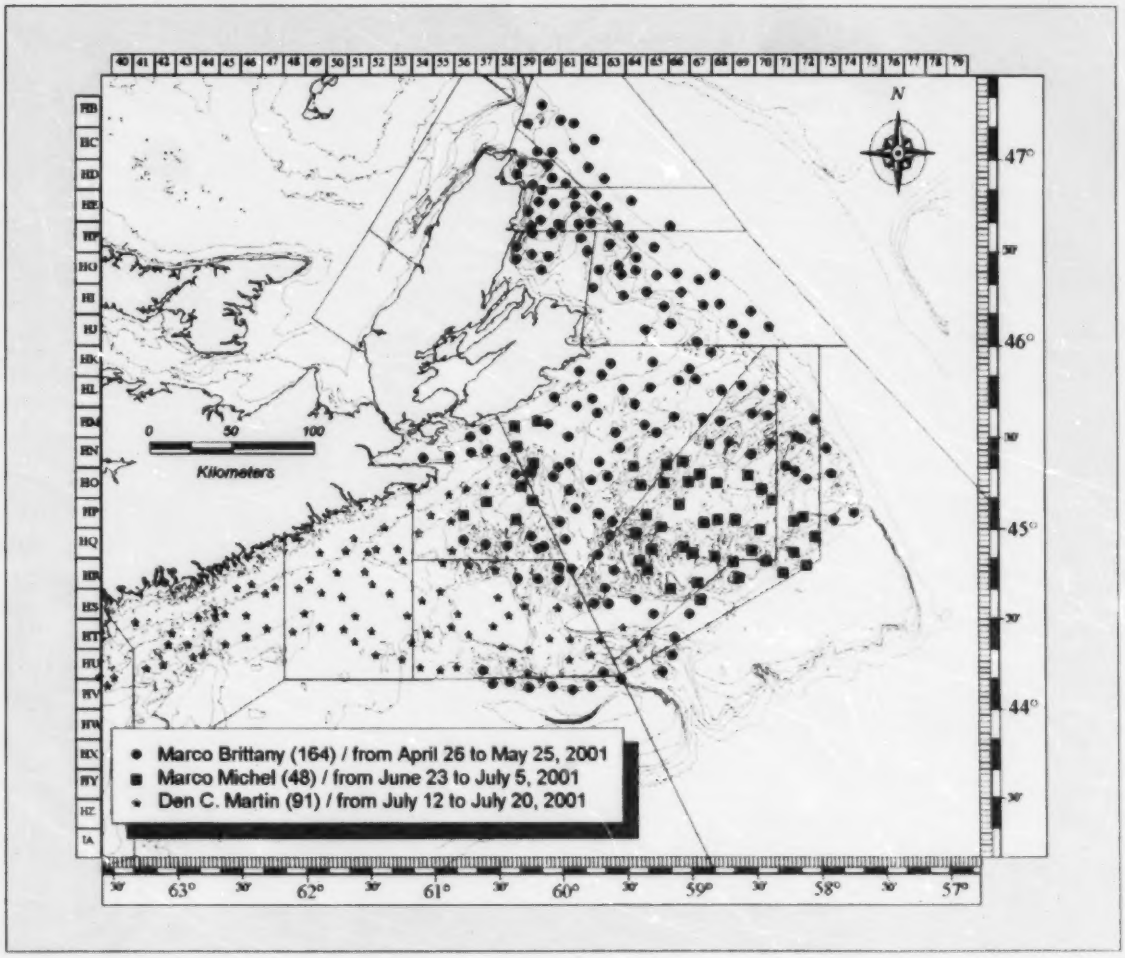


Figure 22. Location of Snow Crab trawl survey stations (N=303) with the different vessels, in 2001.

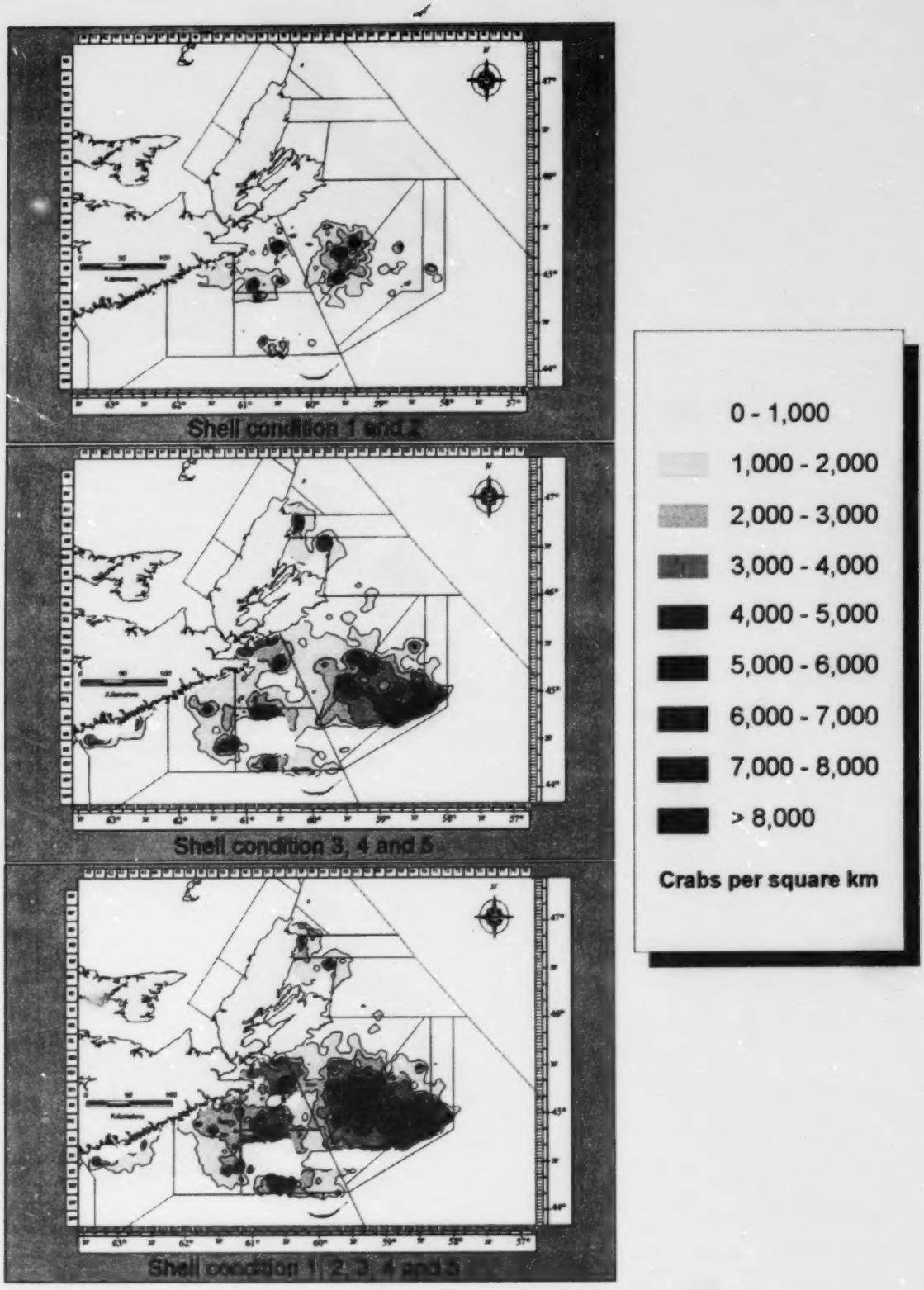


Figure 23. Snow Crab density distribution of adult males (≥ 95mm carapace width) for different shell conditions, in 2001.

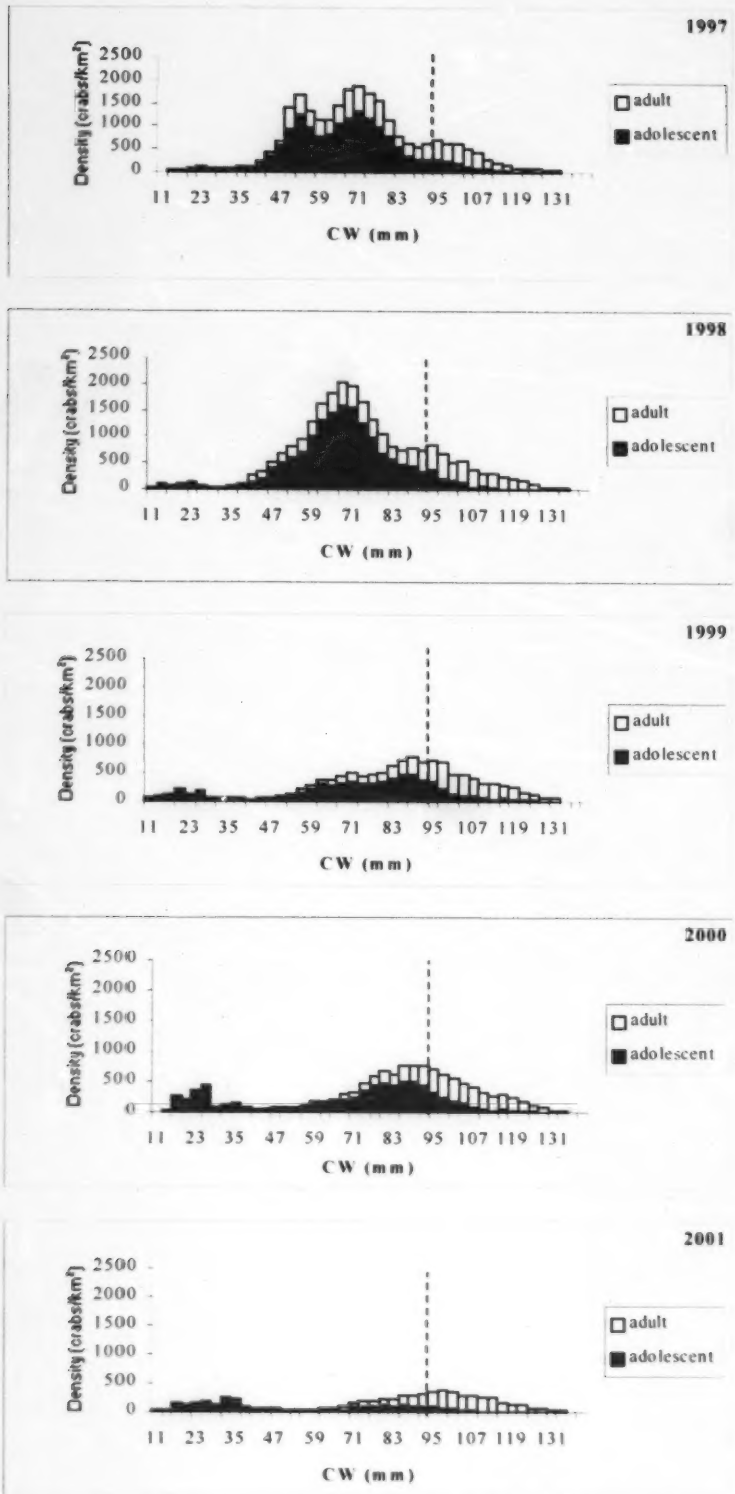


Figure 24. Survey size frequency of male Snow Crab in southeastern Nova Scotia from 1997 to 2001.

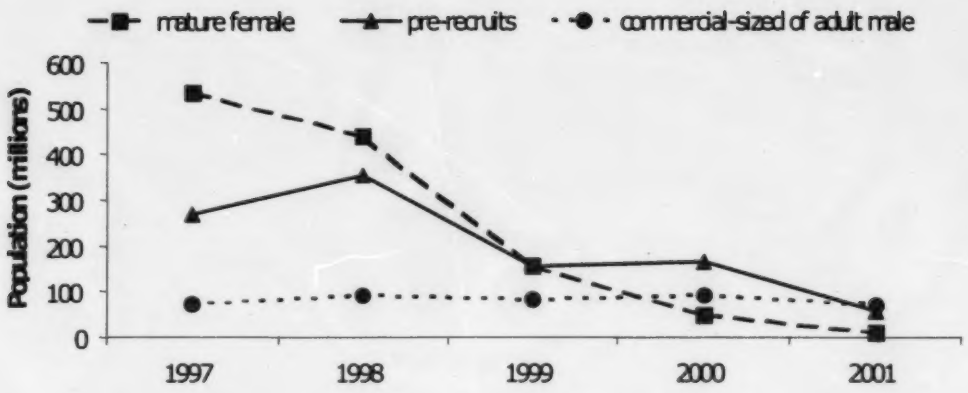


Figure 25. Number of mature females, pre-recruits and commercial-sized adult males in southeastern Nova Scotia.

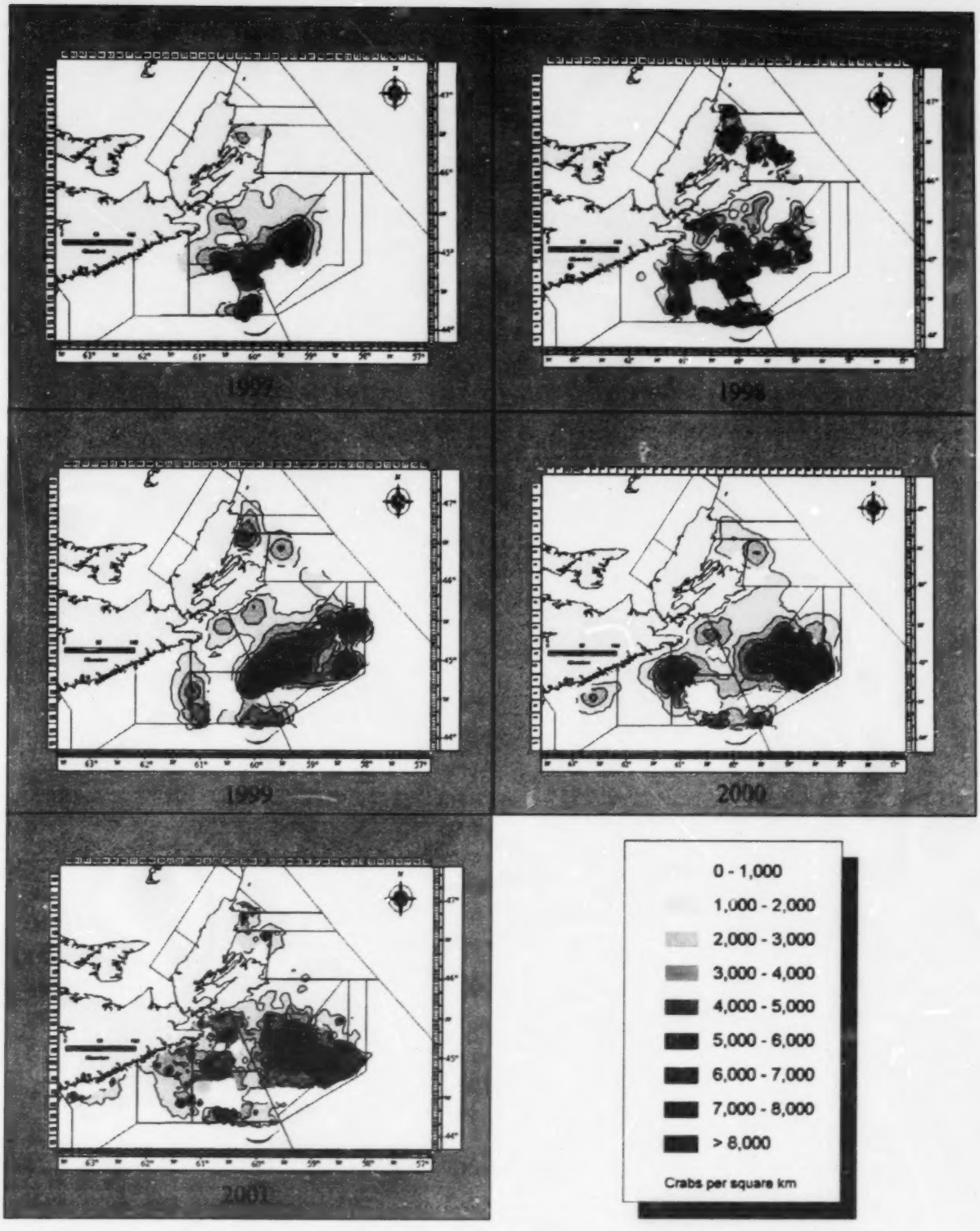


Figure 26. Snow Crab density distribution of adult males (≥ 95mm carapace width) since 1997.

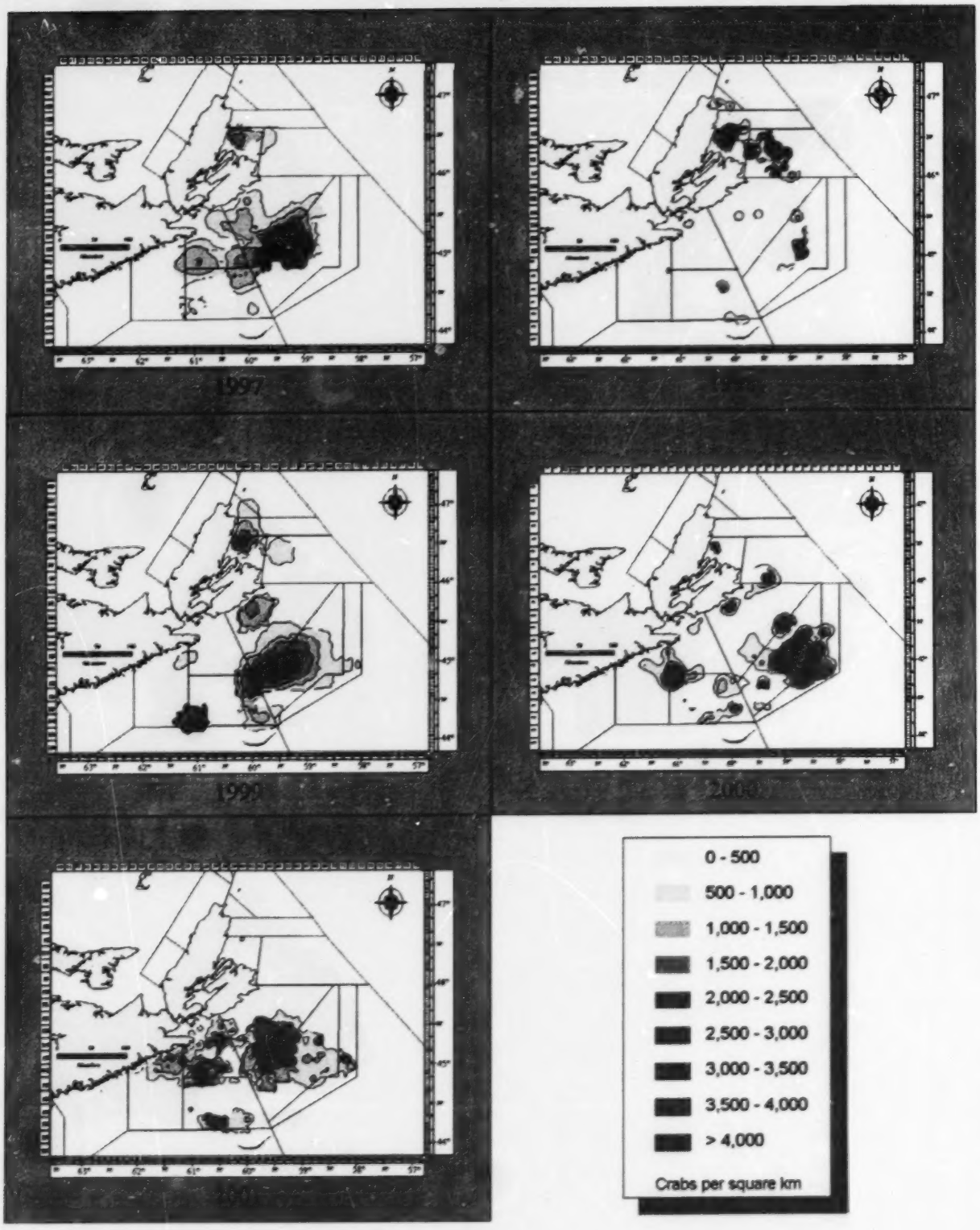


Figure 27. Snow Crab density distribution of adult male (≥ 95mm carapace width) soft-shell crab since 1997.

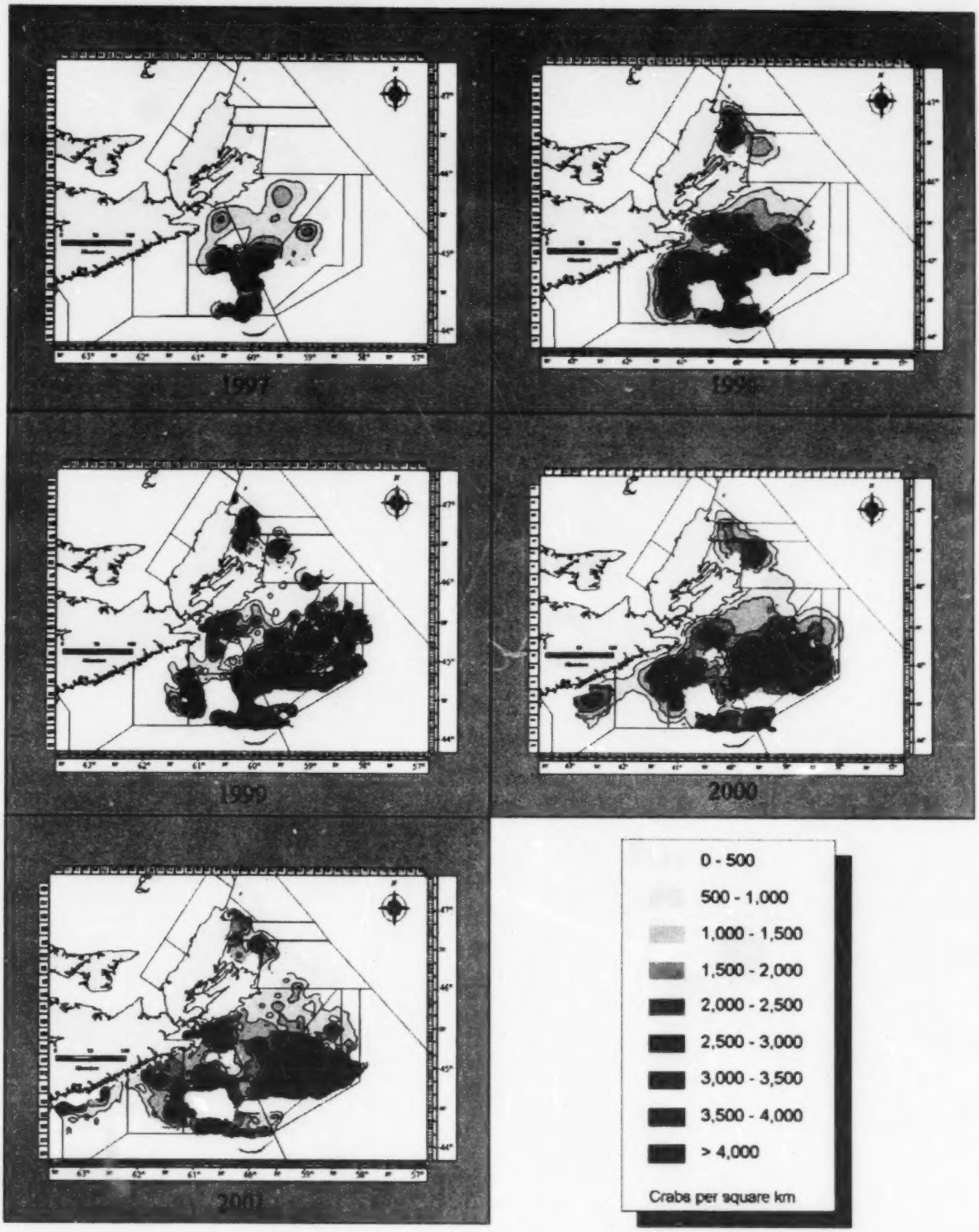


Figure 28. Snow Crab density distribution of adult male (≥ 95mm carapace width) hard-shell crab since 1997.

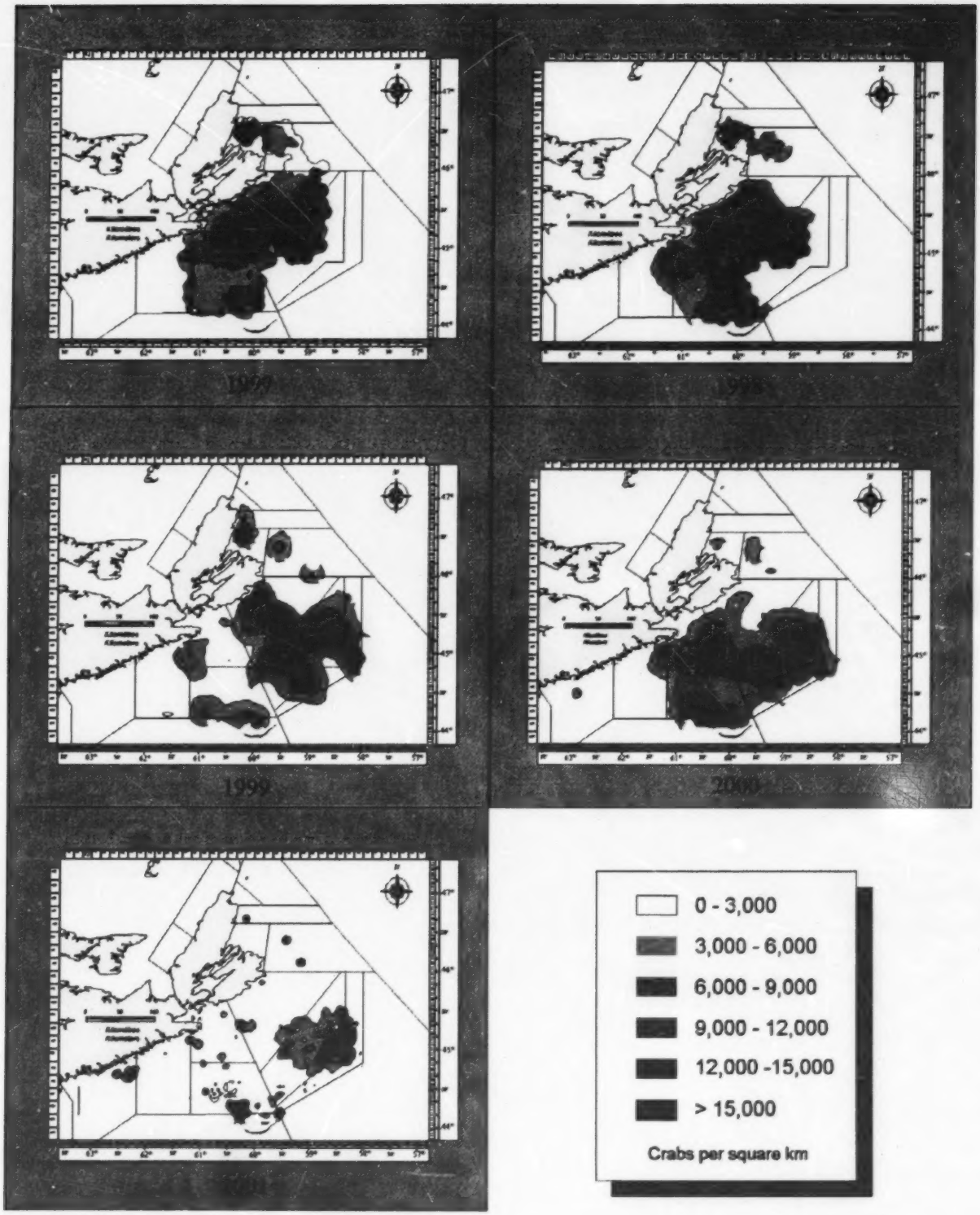


Figure 29. Snow Crab density distribution of adolescent male (≥ 56mm carapace width) since 1997.

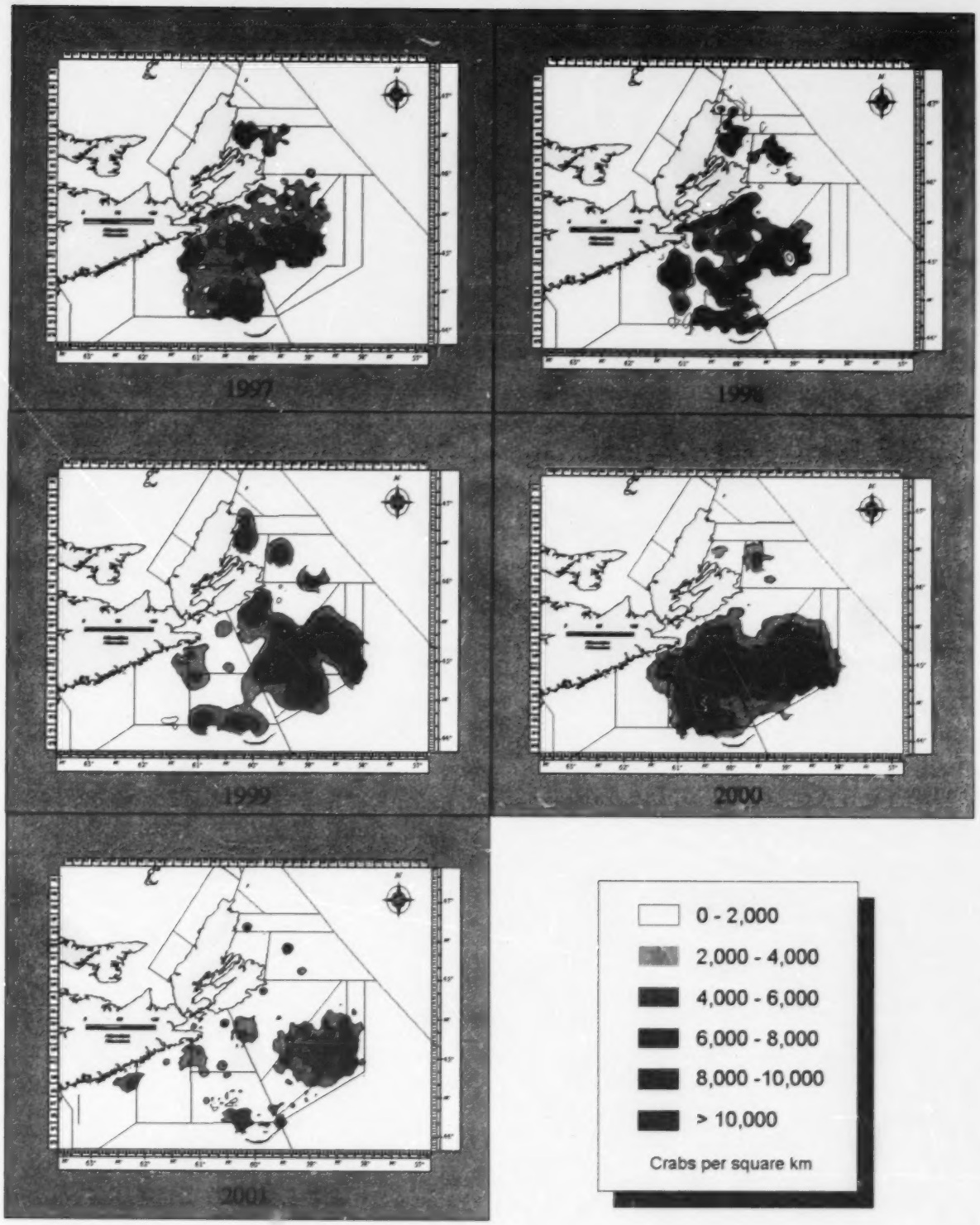


Figure 30. Snow Crab density distribution of adolescent male (≥ 76mm carapace width) since 1997.

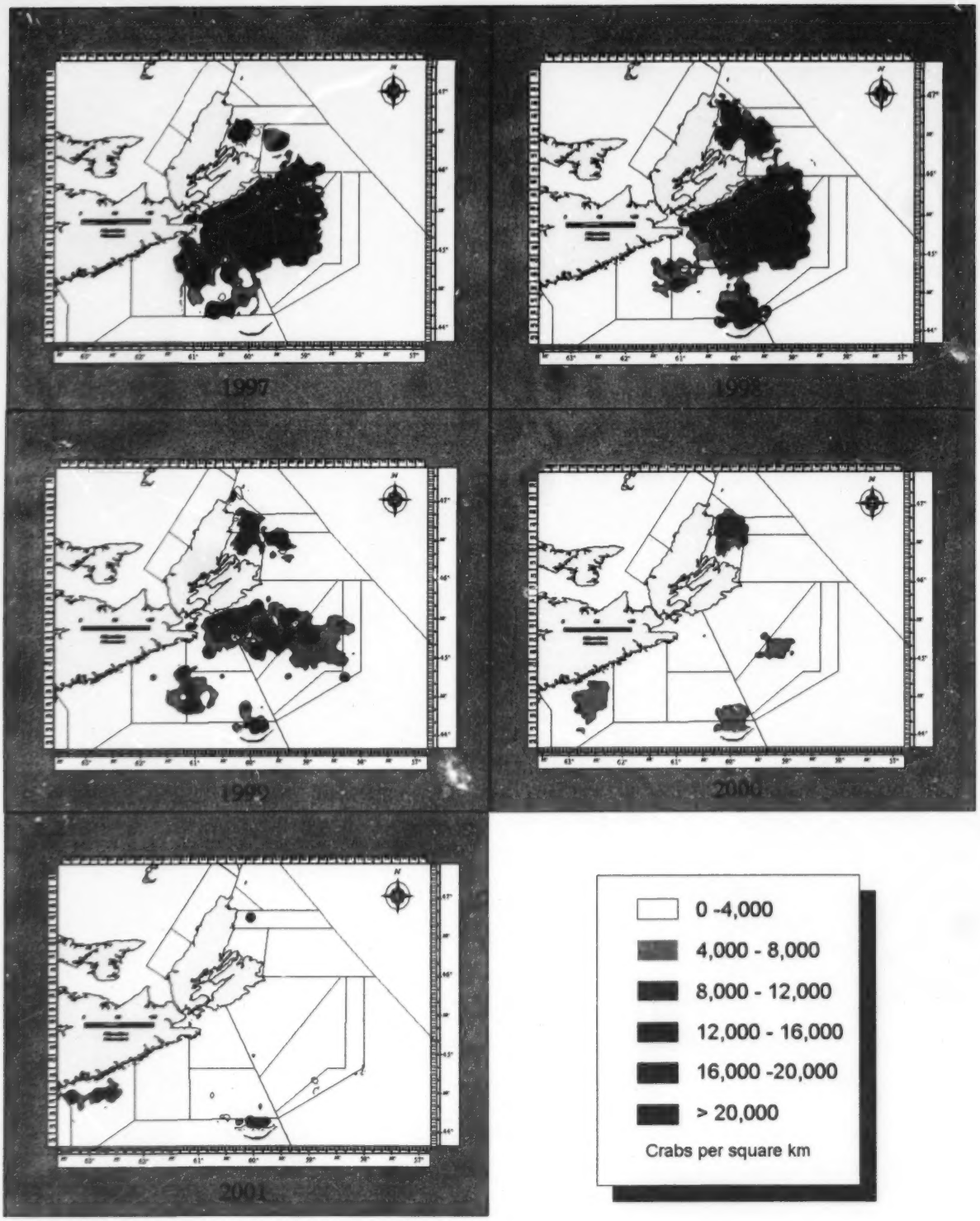


Figure 31. Snow Crab density distribution of mature female since 1997.

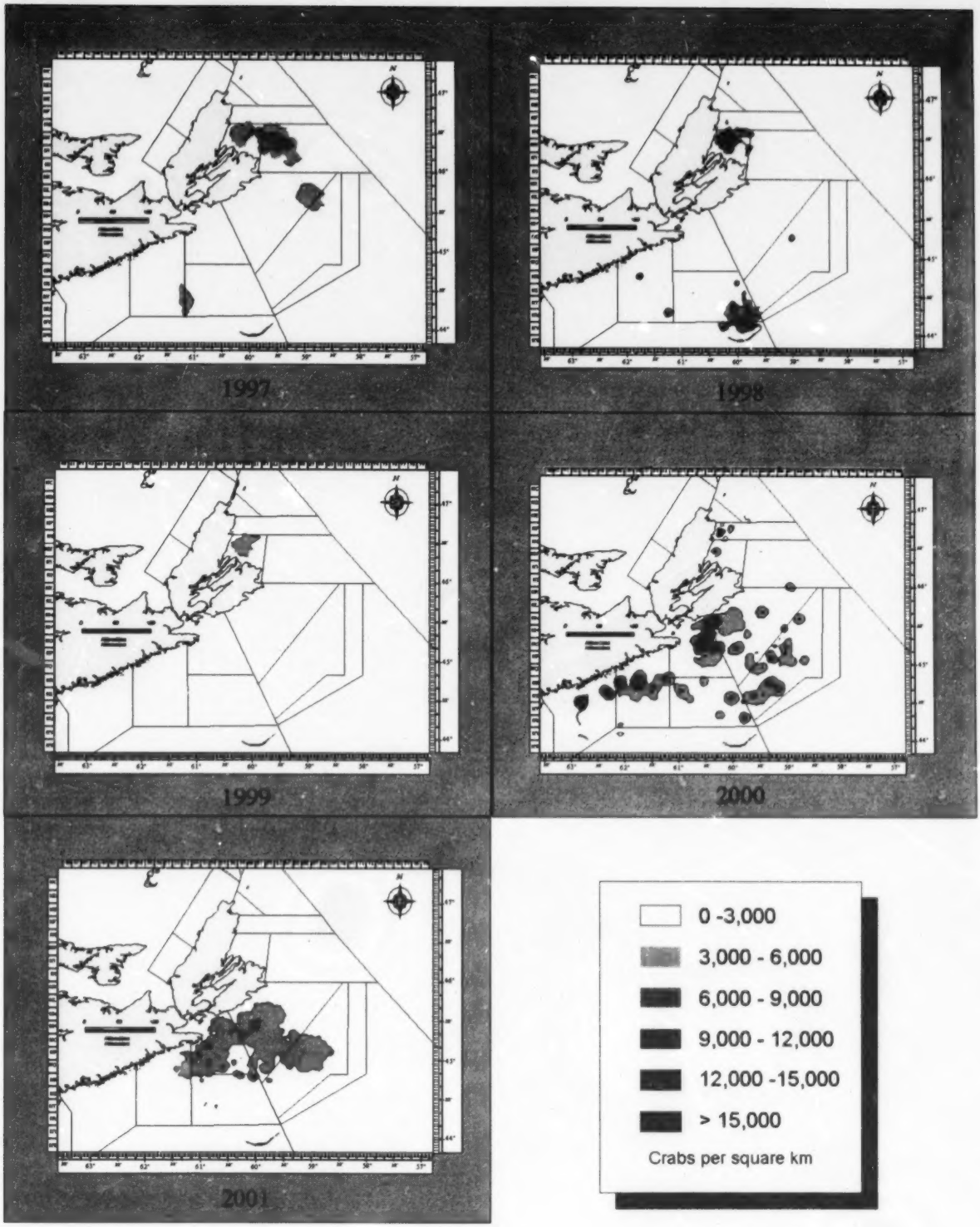


Figure 32. Snow Crab density distribution of immature female since 1997.

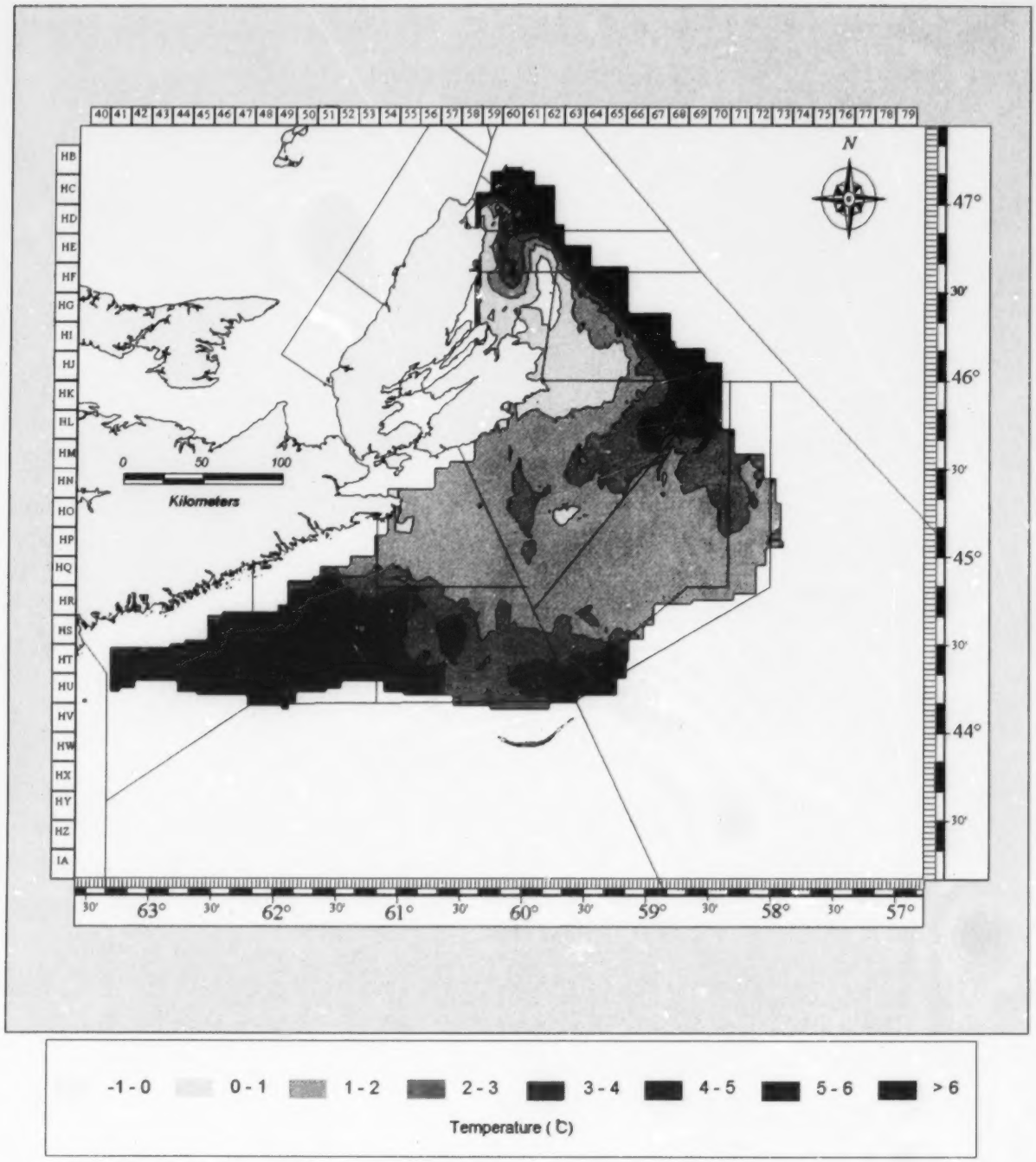


Figure 33. Temperature data from the Snow Crab trawl survey in 2001.

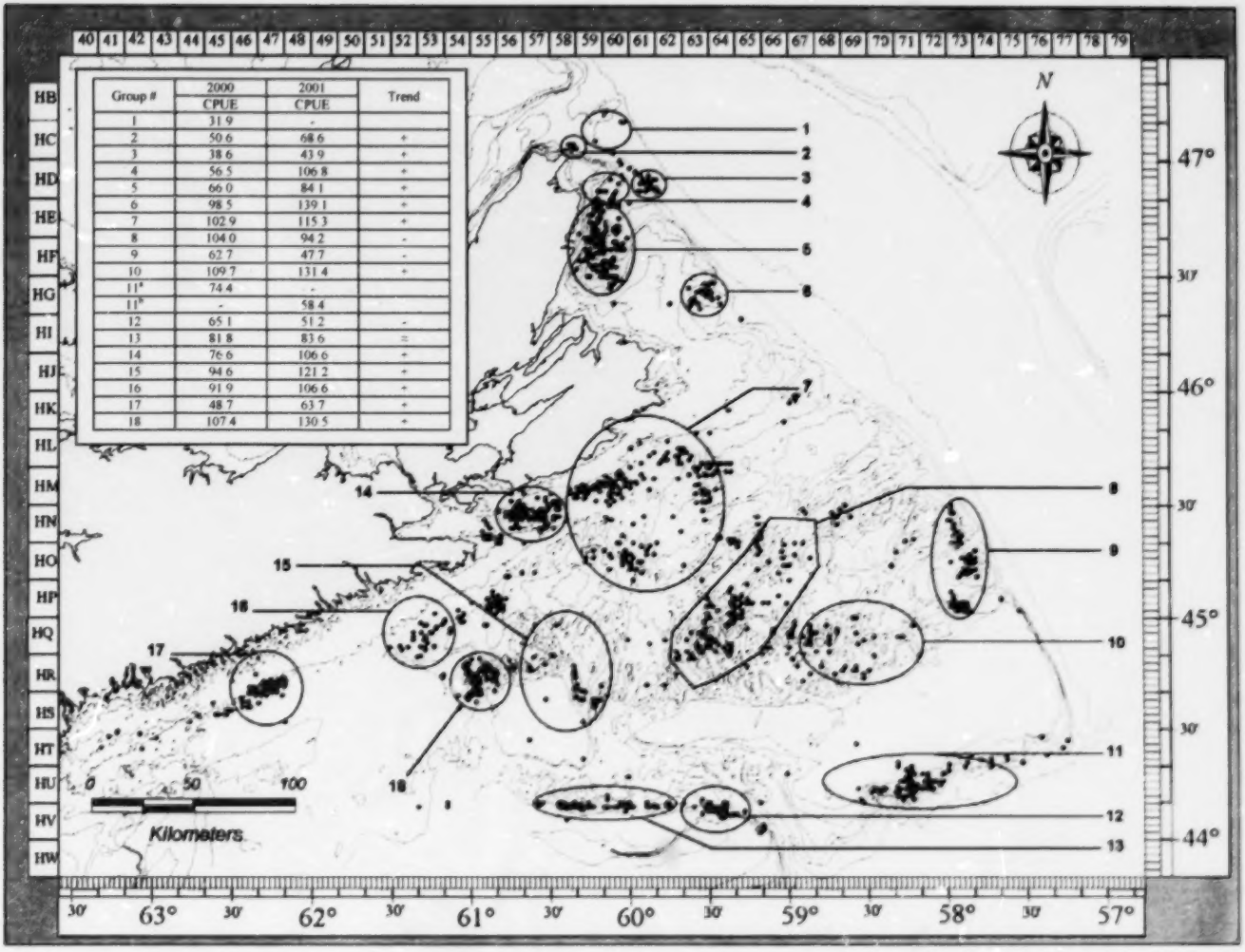


Figure 34. Catch per unit effort for different groups without taking into consideration the areas.

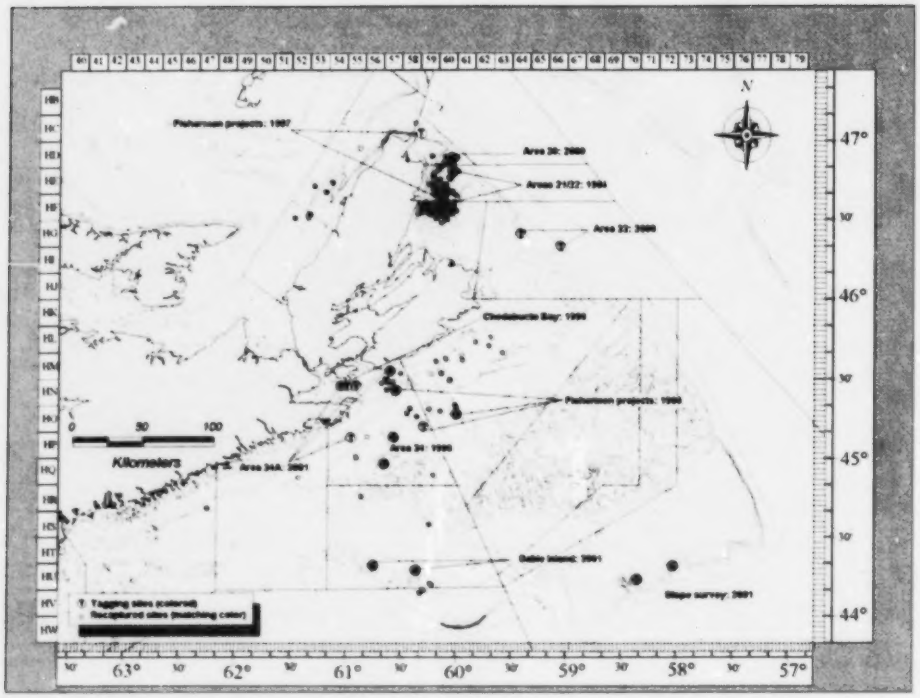


Figure 35. Tagging and recapture sites for eastern Nova Scotia (areas 20 to 24).

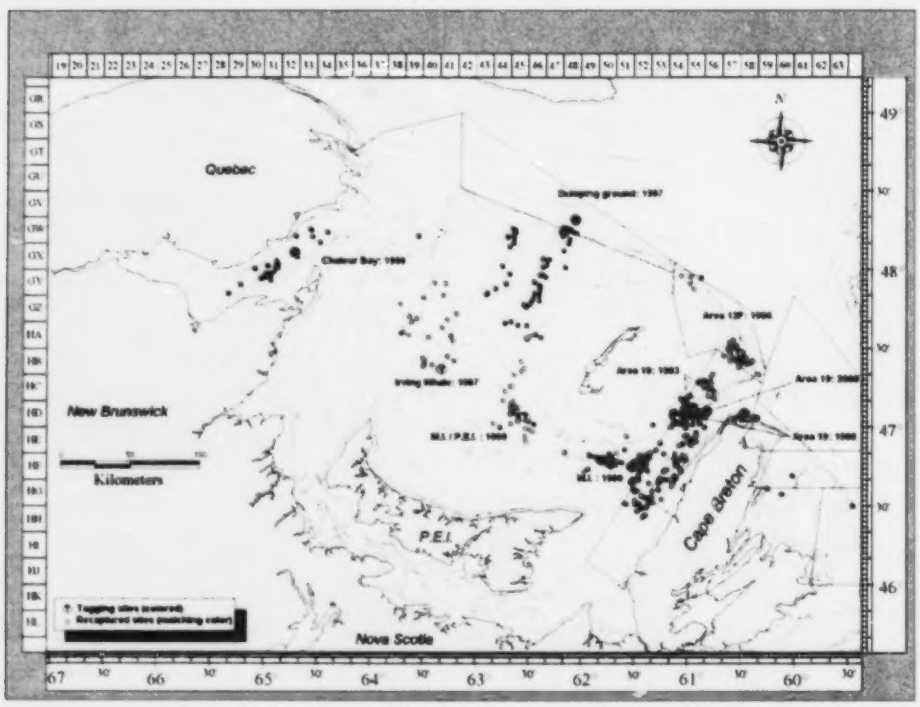


Figure 36. Tagging and recapture sites for the southern Gulf of St-Lawrence (Areas 12, 18, 19 and Area E and F).

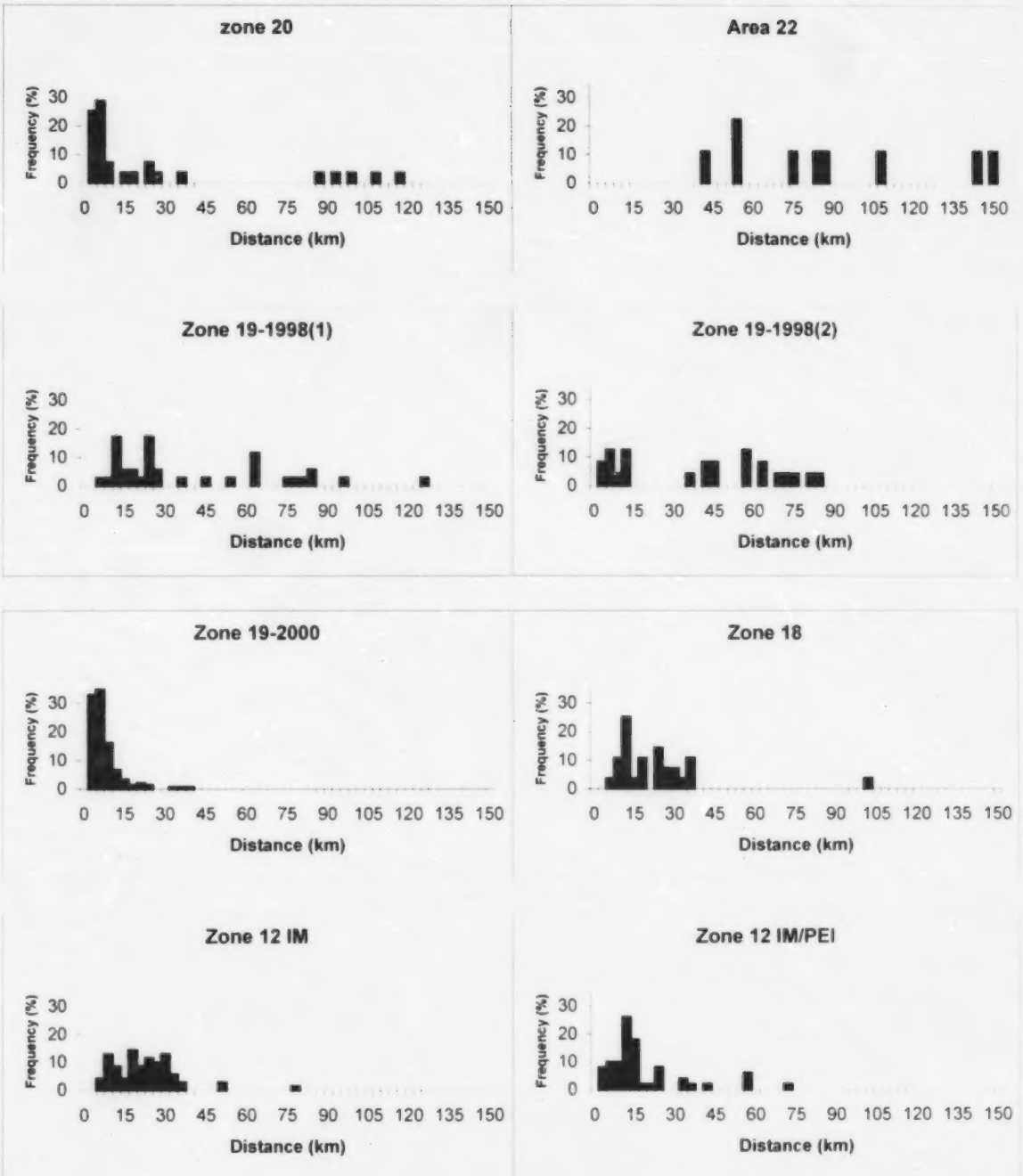


Figure 37. Frequency (%) of recaptured crab versus distance travelled compared to other tagging sites.

Appendix 1

Classification of carapace stages developped for the SGSL stock based on carapace condition, durometer reading and corresponding approximate age after terminal molt (modified from CAFSAC 1991; Anonymous 1994).

Category	Stage	Durometer reading	Carapace condition	Approximate age after terminal molt
New soft	I	< 68	brightly colored, iridescent, soft, no epibionts, chelae easily bent.	0-5 months
Clean	II	variable	brightly colored, some iridescence, may have epibionts, chelae not easily bent	5 months- 1 year
Inter-mediate	III	> 68	dull brown dorsally and yellow-brown ventrally, no irridescence, shell abrasion evident, epibionts.	8 months -3 years
Old	IV	> 68	carapace very dirty but hard, decay may be present at leg joints, epibionts removable at processing plant.	2 - 5 years
Very old	V	variable	carapace very dirty and may be soft (durometer reading < 68), progression of decay may be evident, epibionts not removable at processing plant.	4-6 years

Appendix 2

Classification of health categories used during the soft and white crab mortality experiment, and based on the vitality and appearance of the snow crab.

Category	Health condition	Characteristics
A1	Alive; excellent	When holding carapace, legs are **horizontal and straight** to the crab; **actively moving**.
A2	Alive; good	When holding carapace, legs are **horizontal and straight** to the crab; **reduced or no movement**.
A3	Alive, fair	When holding carapace, legs are **slightly hanging** (<45° angle to the crab); **mandibles are moving**; **abdomen returns tight** to the body once pulled.
B	Weak	When holding carapace, legs are **hanging** (>45° angle to the crab); **mandibles are not moving** (except if pulled); **abdomen does not return tight** to the body once pulled.
C	Dead	No movement, even after stimulation

Appendix 3

Table 1. Seasonal catch composition, in number, from at-sea samples for eastern Nova Scotia (Areas 20 – 24) in 2001.

a) Catch composition in Area 20 (in number).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
4	16	< 95 mm	7	62	1	0	8	62	70
		> 95 mm	10	324	2	2	12	326	338
		total	17	386	3	2	20	388	408

b) Catch composition in Area 21 (in number).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
7	13	< 95 mm	69	21	9	0	78	21	99
		> 95 mm	213	164	32	11	245	175	420
		total	282	185	41	11	323	196	519

c) Catch composition in Area 22 (in number).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
8	40	< 95 mm	11	303	1	3	12	306	318
		> 95 mm	26	1,100	10	75	36	1,175	1,211
		total	37	1,403	11	78	48	1,481	1,529

Appendix 3

Table 2. Seasonal catch composition, in number, from at-sea samples for Crab Fishing Area 23 in 2001.

a) Catch composition in CFA 23, all sub-areas (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
78	638	< 95 mm	552	2,037	105	63	657	2,100	2,757
		> 95 mm	2,708	17,341	562	1,763	3,270	19,104	22,374
		total	3,260	19,378	667	1,826	3,927	21,204	25,131

b) Catch composition in CFA 23, sub-area A (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
27	167	< 95 mm	221	814	29	19	250	833	1,083
		> 95 mm	543	4,530	144	581	687	5,111	5,798
		total	764	5,344	173	600	937	5,944	6,881

c) Catch composition in CFA 23, sub-area B (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
22	147	< 95 mm	188	454	33	17	221	471	692
		> 95 mm	684	3,915	160	731	844	4,646	5,490
		total	872	4,369	193	748	1,065	5,117	6,182

d) Catch composition in CFA 23, sub-area C (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
2	16	< 95 mm	10	101	3	0	13	101	114
		> 95 mm	20	472	7	4	27	476	503
		total	30	573	10	4	40	577	617

e) Catch composition in CFA 23, sub-area D (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
27	283	< 95 mm	133	668	40	27	173	695	868
		> 95 mm	1,461	8,424	251	447	1,712	8,871	10,583
		total	1,594	9,092	291	474	1,885	9,566	11,451

Appendix 3

Table 3. Seasonal catch composition, in number, from at-sea samples for Crab Fishing Area 24 in 2001.

a) Catch composition in CFA 24, all sub-areas (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
60	532	< 95 mm	731	1,848	160	37	891	1,885	2,776
		> 95 mm	3,765	12,986	430	1,198	4,195	14,184	18,379
		total	4,496	14,834	590	1,235	5,086	16,069	21,155

b) Catch composition in CFA 24, sub-area A (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
22	165	< 95 mm	180	641	17	3	197	644	841
		> 95 mm	1,034	3,816	132	605	1,166	4,421	5,587
		total	1,214	4,457	149	608	1,363	5,065	6,428

c) Catch composition in CFA 24, sub-area B (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
8	52	< 95 mm	61	98	9	1	70	99	169
		> 95 mm	408	1,866	20	84	428	1,950	2,378
		total	469	1,964	29	85	498	2,049	2,547

d) Catch composition in CFA 24, sub-area C (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
2	9	< 95 mm	2	32	2	1	4	33	37
		> 95 mm	14	264	6	39	20	303	323
		total	16	296	8	40	24	336	360

e) Catch composition in CFA 24, sub-area D (%).

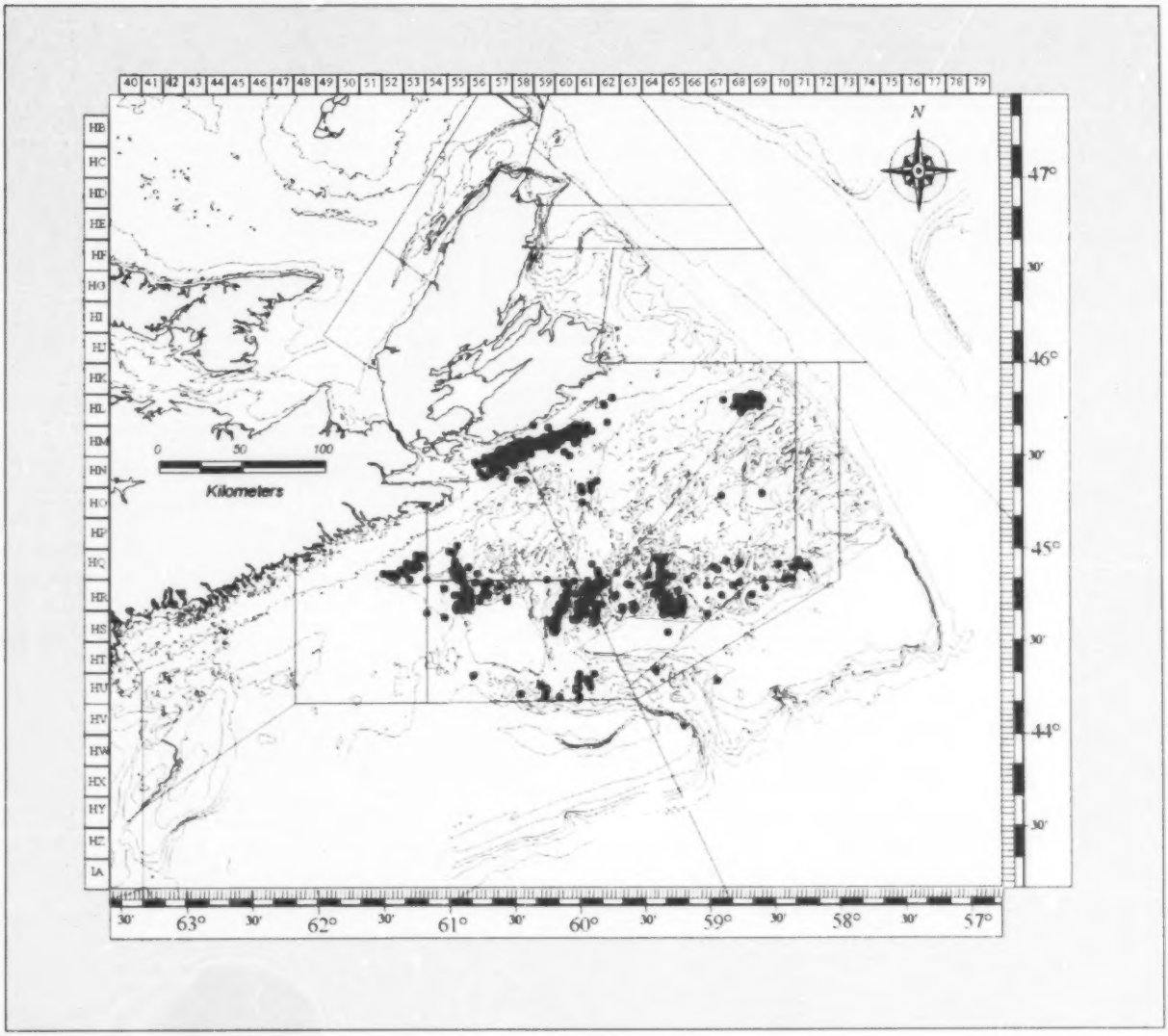
Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
16	204	< 95 mm	364	405	116	18	480	423	903
		> 95 mm	2,105	4,806	252	305	2,357	5,111	7,468
		total	2,469	5,211	368	323	2,837	5,534	8,371

f) Catch composition in CFA 24, sub-area E (%).

Coverage		Size	Hard shell crab		Soft shell crab		By maturity stage		Total
trip	trap		adolescent	adult	adolescent	adult	adolescent	adult	
12	90	< 95 mm	124	672	16	14	140	686	826
		> 95 mm	204	2,234	20	165	224	2,399	2,623
		total	328	2,906	36	179	364	3,085	3,449

Appendix 4

Shrimp fishery positions in eastern Nova Scotia in 2001.



Appendix 5

Table 1. Retrospective Traffic Light Analysis (1998-2000) and current assessment (2001).

Northern ENS	1998	1999	2000	2001
Fishery Data				
CPUE (kg)				
Effort (# trap haul)				
Size (carapace width)				
Survey Data				
Biomass/abundance index				
Recruitment (juveniles)				
Recruitment (R-1)				
Other Data				
Temperature				
Industry perspective				
Score				

Southern ENS	1998	1999	2000	2001
Fishery Data				
CPUE (kg)				
Effort (# trap haul)				
Size (carapace width)				
Survey Data				
Biomass/abundance index				
Recruitment (juveniles)				
Recruitment (R-1)				
Other Data				
Temperature				
Industry perspective				
Score				

Appendix 5

Table 2a. Annual landings, catch rate and effort statistics for Snow Crab in northeastern Nova Scotia, 2001 (CFAs 20, 21 and 22), 1997-2001.

Year	Active licenses/permits	TAC (t)	Landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1997	74	540	534	23.3	22.9
1998	74	660	657	41.6	15.8
1999	78	900	899	54.8	16.4
2000	79	1,015	1,017	68.3	14.9
2001	80	1,065	1,066	94.1	11.3
Average (97-01)		836.0	834.6	56.4	16.3

Table 2b. Annual landings, catch rate and effort statistics for Snow Crab in southeastern Nova Scotia, 2001 (CFAs 23 and 24), 1997-2001.

Year	Active licenses/permits	TAC (t)	Landing Statistics (t)	Total mean CPUE (kg/trap haul)	Total Effort (1000's of trap hauls)
1997	59	1,163	1,157	50.9	22.7
1998	67	1,671	1,558	68.9	22.6
1999	-	2,700	2,700	71.1	38.0
2000	158	8,799	8,701	85.0	102.4
2001	167	8,823	9,112	88.5	102.9
Average (97-01)		4,631	4,646	72.9	57.7